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VOL. 21 OCTOBER 1960 No. 4

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

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FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 21 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (October 17, 1958).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1960

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RAILROAD FIRES[1]

MERLE S. LOWDEN
Director, Division of Fire Control, U. S. Forest Service,
Washington, D. C.

I welcome the opportunity to meet with you to consider the very important subject of railroad fire prevention. Fire prevention, like the frequency of man-caused fires, has its "ups" and "downs." Apparently we are in an "up" period nationally. All protection agencies taken collectively have had an upsurge in man-caused fires during the past 2 years. Many explanations are given for this but it would be difficult to be certain of the true cause. Apparently, there is no one cause but several. This upswing in man-caused fires has focused renewed attention on fire prevention.

We are beginning some fire prevention research aimed at trying to determine the exact cause for fires, the reason behind the cause, and at trying to evaluate the various prevention efforts now used with all man-causes. We look forward to the time when application of increased knowledge and improved methods will greatly reduce fires within the forests. We hope railroad fires will follow this path. Recent experience on the national forests has been encouraging.

Railroad fires have been of concern to the Forest Service since we were given the job of protecting the national forests nearly 60 years ago. Fires from railroad causes were very common in western national forests in the early days. Not much attention was paid to either suppression or prevention in those times. As we were able to greatly reduce the acreage burned and resulting damages through better fire control, we began to give more attention to preventing all fires. We recognize that the best fire is the one that never happens. This emphasizes prevention.

In examining the fire record of the national forests for the past 10 years, I note that there has been a general reduction in railroad fires, but the pattern by regions and national forests is irregular. For example, for the 5-year period 1949-54 there were 1,082 railroad fires on the national forests. For the next 5 years this had dropped to 604 or to nearly one-half.

When I set out to plan this paper I asked each Forest Service region for ideas on railroad fire prevention. This included their problems, programs aimed at fire prevention, changes taking place in relations with railroads, and suggestions for betterment. Most regions pointed to a marked decrease in railroad fires. For instance, in Alaska, there have been only three railroad fires on the national forests in the last 6 years compared to 148 in the previous 5 years. Other regions report a fluctuating situation. Where the situation has improved materially our men credit the improvement to both technology and man's actions. Conversion to diesel equipment, installation of improved spark arresters, new systems of central control which eliminate use of fusees, and other devices have done much to better the situation. I think we must recognize also the improvement in people's habits and in the attention given this problem by the railroads. I am sure there is greater care in tie burning, smoking, right-of-way burning, and similar work jobs. Either Smokey Bear is reaching the railroad employees, or more railroads are giving direction to fire prevention. These and other means are bringing about a better realization of the need to be careful with fire. I will mention more about programs and their merits.

---

[1] A paper given at the Railroad Fire Prevention Conference, Roscommon, Mich., June 6-8, 1960.

But now let's analyze briefly the specific causes of railroad fires. I was unable to get a complete breakdown of causes, but I think we all recognize those most common and prevalent. Locomotive sparks have, in the past, and continue to be, one of our big worries. Conversion from steam to diesel locomotives has helped. However, we can be certain that diesel engines still cause many fires. One of our big problems is to convince some that diesel engines, whether they be on the railroads, in tractors, or in motor vehicles, can and do cause fires. For several years we have contemplated a new study on the ignition properties of various carbon sparks on forest fuels. Needed answers have been slow because of little financing for such work and our inability to obtain cooperation from industries that should be interested in this subject. Engine manufacturers, fuel producers, and others should be willing to support a program for getting better answers. We are hoping something like this can be worked out soon.

The seriousness of the internal combustion engine spark problem is almost in direct ratio to the number of days of bad fire conditions in any particular area. For instance, one region reports they have a problem whenever humidity is below 25 percent and a particularly serious one when humidity drops to 15 per cent or below. There, of course, are many related sidelights to this problem. These concern idling engines, steep grades, lack of adequate arresters, poor maintenance of equipment, and similar deficiencies.

Brakeshoe sparks are a serious problem and, in some localities, appear to have replaced engine sparks as the No. 1 "boogie." It has been difficult for me to find specific information regarding this cause. Several of our regions reported an improved situation with the changeover to dynamic brakes. I don't know what dynamic brakes are but if they will stop brakeshoe sparks, I am all for them. Brakeshoe fires are still a serious problem and need attention.

These two important causes are of a mechanical nature. People are involved, but their responsibility is not so apparent. There is, however, a set of causes associated with railroads which relate directly to the acts of individuals—usually railroad company employees, although in a few cases they may be users. Under this general class I include tie burning which is a serious risk in dangerous fire weather. There is the ever present problem of smoking by employees and users. Smoking is our No. 2 man-caused fire problem nationally.

Fusees set along tracks to warn approaching trains are a common fire cause. The increased use of central controls or other means of nonfire signaling are encouraging. However, these methods are not practicable in all instances and we continue to have fusee fires in many localities. Generally we no longer have wood-or coal-burning locomotives but there is still a problem of sparks and ashes from dining car stoves, and stoves in mail or express cars and cabooses. Some railroads use coal or briquettes. Sparks may be observed rolling from chimneys at night, and ashes, if dumped in a hazardous place, easily start fires. Right-of-way burning, while preventing many fires, still causes fires. These fires usually result from burning too late in the fire season, or from inadequate preparation and lack of precaution during actual burning. Burning is a valuable tool but it is not cheap and requires skill and care to assure fires do not escape the planned area. Hobos are another cause directly related to railroads and men, but I am not sure you can entirely blame the railroads. These voyagers of the railroads have largely transferred their allegiance to the paved highway and hitchhiking, but a few "jungle" camps have "residents" who cause fires by careless smoking or campfires.

I have given a brief rundown of the problem. Now what can we do about it? Actually that is why we are here and I would be presumptuous if I were to claim knowledge of the complete answer. However, to get things started, it might be well to list some of the things that I believe should be done to a greater extent than at present. In the sparks-from-engine field there are many developments taking place in arresters. It is refreshing to hear of success experiences such as the major railroad on the west coast that has practically eliminated locomotive fires in one year with a new turbo type arrester. I recall at a former meeting such as this there was much talk regarding fuels and additives and what might be done in that line regarding the problem. Undoubtedly there have been developments since then although they have not been brought forcefully to my attention. I am sure we will hear more about them before this meeting is over.

There was also previous mention of engine design. I am now getting entirely out of my field, but if something can be done in the original design of engines to eliminate fire-starting sparks, certainly that will be very worthwhile. Many of our field people tell me that when new diesels are first put into operation they do not cause fires, but as they get older they begin to give trouble. This probably goes back to contributing problems of equipment inspection and maintenance. These are important if we are to be sure equipment does not emit dangerous sparks. Engines permitted to idle for a long time at one place and build up carbon often throw sparks. I know this problem is not easily cured but it must be met.

As I mentioned previously, I hear some very good reports on dynamic braking as a remedy for the brakeshoe problem. Again this is not within my field of experience or knowledge, but I am sure that additional work could be done on braking materials, or perhaps dynamic brakes can be adopted universally. If this is not possible, simply a matter of more care offers some remedy.

When we get into the field of people's actions we are, of course, exploring the field of why people do things and what influences them. Here we need some human "research." Recently I attended a management session in which one thing said frequently was "don't look under the hood" in relation to people. However, I feel we must "look under the hood" to find out why people do things if we are to change their habits.

Education is needed with railroad people as well as with others. This can be done through posters, talks, articles in trade publications, and similar media. It has always been somewhat of an enigma to me why some major railroads do not show more concern about damaging fires caused by their operations. I believe much can be done to cure a basic problem if all companies show more concern. Employees usually reflect the policies and concern of management. If management is genuinely concerned about stopping fires, the actions of the employees are going to be influenced.

Then, of course, there are a lot of "doing" jobs which can help eliminate railroad fires. Removing hazardous growth from the rights-of-way is a positive measure, but in these days of concern with soil erosion and attention to land management we can expect an increasing public concern about burning or excessive removal of vegetation from rights-of-way. In total, these rights-of-way amount to a lot of land area in the United States. Plowing or bulldozing firebreaks also creates some problems. Not enough has been done to find fire-resistant, slow-growing plants for ground cover. We are looking for some such plants for the mountains of Southern California to replace highly flammable brush which is now the principal watershed cover. If some good new cover is developed, I am sure the information will be passed along to the railroads for widespread use.

A field of action which we usually try to avoid, but which has its place in any complete program, is law and regulation. Where railroads cross national-forest land, we have regulating clauses in use permits and agreements. These have been helpful in the total fire problem even though they have sometimes been resisted by railroads, and have been the subject of more than one verbal battle. Many States have regulatory laws requiring cleanup and certain preventive devices on the equipment. In our present society, laws and regulations are necessary and I think will continue to be necessary in railroad fire prevention. However, I hope, in the long run, education and a cooperative approach will greatly reduce our railroad fires and eliminate the need for more laws or regulations.

I am sure large fire suppression bills and damage payments for railroad-caused fires have been a strong deterrent to more fires. Fire prevention is a major objective of law enforcement. However, we would much rather prevent a fire than prepare necessary reports and make a case for collecting costs and damages. These are necessary when government property is destroyed or costs incurred by carelessly caused fires. I hope, in the future, our program can be largely based on a cooperative approach in which the protection agencies, the railroads, fuel companies, equipment manufacturers, and others concerned would each assume responsibility to better the current record.

Our regions report encouraging results of meetings between Forest Service and railroad people, many of which have been held jointly with State and other protection agencies. Joint inspections of rights-of-way and equipment, annual discussion of problems, memos of understanding and local arrangements all fit this cooperative picture. I am optimistic that by assuming an attitude of cooperation and by working hard at it we can materially better our railroad fire record in the coming years. Certainly this is a program that we can join without controversy and one I can assure you the Forest Service will do all it can to further.

TRACTOR-PLOW LINE BURNING DEVICE

L. W. LEMBCKE

Chief, Mechanical Section, Wisconsin Conservation Department[1]

For many years, tractor-plow fire suppression units have been in use. Each year thousands of fires are suppressed, and over the years detailed information has been provided on the tactical use of tractor-plows. The basis for widespread adoption of the tractor-plow has been the speed at which good line can be constructed.

The amount of line that can be constructed, however, is only part of the story and is not as important as the amount of held line. It has been stated that the rate of line holding is generally about one-fourth the rate of line plowing. If this is the situation, either the rate of line holding should be increased or the rate of line plowing reduced.

Experience in Wisconsin can be compared with experience elsewhere. Equipping tractor units with two 75-gallon saddle tanks and a power take-off pump has increased the rate of held line. Late model tractors with more powerful engines and longer tracks, and equipped with hydraulic pumps for plow control, seem likely to increase the rate of line plowing, and the 3 to 1 ratio may maintain.

The need for adequate burning out of lines at a greater rate of speed was recognized, and all the varieties of backfiring devices from fusees to drip torches were tried out over the years. The limiting factor, if there was only one, seemed to be the rate at which known devices, and these must be lightweight, could burn out line under most conditions. Man-carried devices were slow and caution usually dictated that fire would not be set faster than the line holding crew felt was safe.

As a result, in many instances the tractor-plow units construct line at their best speed and depend on both line holding crews and numerous plow lines to establish early control. Quite often this effort is successful, but on high intensity fires the amount of line plowed is many times the amount of line held. This has many obvious disadvantages.

An approach to the problem of more nearly equalizing the ratio of line holding to line plowing is the installation of an automatic burning device on our standard sulky plow (fig. 1). The entire operation is controlled by the tractor operator and requires no manual effort other than the operation of a switch.

The fuel is L-P gas (propane) contained in two 40-pound tanks securely mounted between the moldboards of the plow and providing a 4- to 6-hour supply. The tanks are connected to an adjustable regulator (reducing valve) which reduces the gas

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[1] Photographs by V. E. Holtz, Wisconsin Conservation Department.

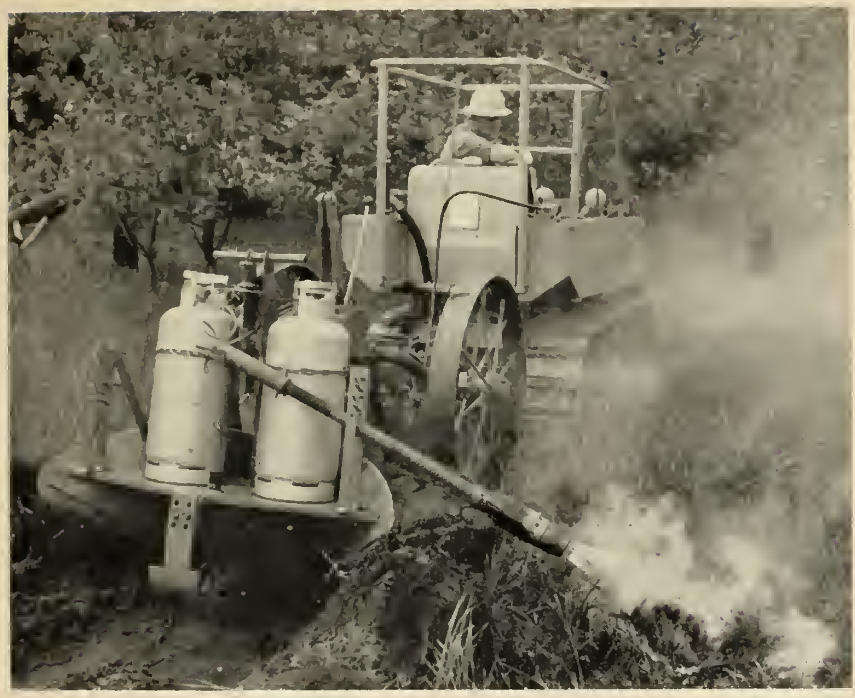

FIGURE 1.—Tractor-plow line burning device in operation.

pressure to a preset level (10-30 pounds) and feeds it to a solenoid valve. The gas flows from the solenoid valve through a rubber (welding) hose to the burner (fig. 2).

The burner is mounted on a heavy coil spring which allows the required flexibility and provides a housing for the gas hose and ignition wire. The burner is a common type L-P gas burner having a capacity of about 300,000 B.t.u. at 30 pounds pressure and will produce a 3-foot flame. A spark plug is incorporated in the burner for igniting the gas. The current for opening the solenoid valve and ignition is taken from the tractor battery and is controlled with a single automobile ignition switch. High voltage for ignition is produced by means of an automobile ignition coil located on the plow. A condenser is located across the points on the switch to give a better spark.

In use, the manual valves on the tanks are opened. Whenever burning is required, the tractor operator, by turning the automotive type ignition switch to the "run" position, opens the solenoid valve permitting the gas to flow through the nozzle. Positioning the switch to the "start" position and releasing it produces one electrical arc on the spark plug. Repetition of the spark plug ignition, if necessary, can be had by repeating the "start" switch operation. Moving the switch to the "off" position closes the solenoid valve shutting off the gas supply.

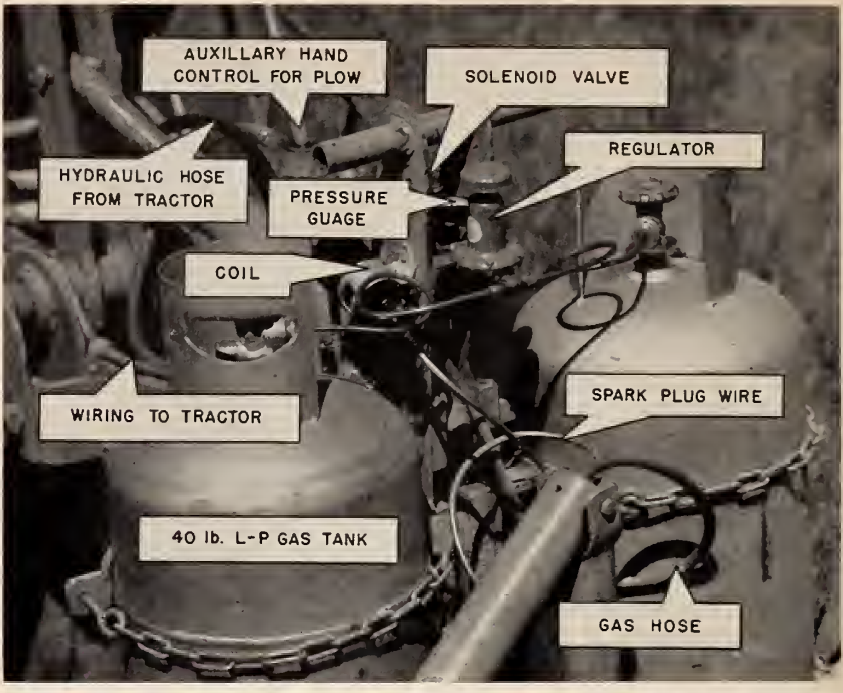

FIGURE 2.—Close-up of ignition system and regulation of gas supply to burner.

The burner head mounting has vertical and lengthwise adjustments to meet the various plowing conditions. Removal of two self-locking pins permits a rapid change from one side of the plow to the other.

As an added safety precaution, the manual control valves on the gas tanks are closed while the unit is in storage. The entire control assembly is protected with a guard, not shown in the photograph. Four units have been installed and are in operation. Continued field use will demonstrate the value of the device and influence the final details of design. Since the installation of the pilot model, minor changes have been made based on experience, but the basic idea is unchanged. Following additional field experience by suppression crews, modifications, if any, will be incorporated and plans developed for more units.

PRESSURIZED PUMP CAN DESIGNED FOR MOPUP

James G. Fisher
Farm Forester, Oregon State Board of Forestry

A new type of backpack pump can has been developed by Doyle Stockton, Assistant District Warden, Oregon State Board of Forestry, Medford, Oreg.

The Stockton pump can is a 2½-gallon container consisting of two cylinders carrying water under pressure (fig. 1). Connections at the top and bottom of the container equalize the pressure and amount of water in the two cylinders. This construction also balances the weight of the water and prevents it from shifting within the pump can.

Water is placed in the pump can by unscrewing the pump located on top of one of the cylinders. A later model will be filled through the top of the other cylinder, whose concave lid is to serve as a container to collect water from shallow waterholes. Pressure for the can is applied by means of approximately forty to fifty strokes of the pump handle.

Using a pistol-type nozzle with adjustable tip, water can be directed just where it is needed in the amount needed and under effective pressure.

A belt-type holster will be developed for the nozzle, leaving both hands free for tool work when water is not needed. The pump can may be mounted on a small packboard, although the can is molded to fit the fire-fighter's back by having a contour plate welded to it.

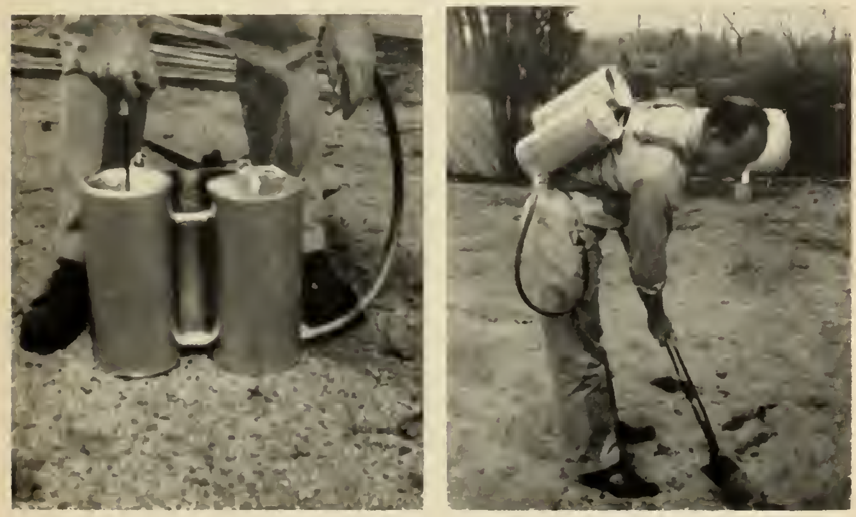

Figure 1.

FIRECLIMATE SURVEY TRAILER

Dean L. Dibble

Forestry Aid, Forest Fire Research, Pacific Southwest Forest and Range Experiment Station

The need for a compact mobile unit to record around-the-clock weather observations with a minimum of attention may be answered by the fireclimate survey trailer (fig. 1). Designed for use on fire environment studies or going fires, this unit packs a full complement of instruments and is readily transported behind a jeep or pickup.

This war-surplus 2-wheel ¼-ton trailer is known to the Armed Forces as the M-100 cargo trailer. It was fitted with a rooflike canopy made of ⅛-inch aluminum and supported by aluminum angles. Each half of the canopy consists of two doors which may be opened in pairs or individually, and the entire top was weather stripped for protection against dust and moisture. The unit is equipped with a recorder, power supply, and weather instruments.

The recorder keeps track of wind speed and velocity on a strip chart. It is an Esterline Angus 20-pen operation (event) recorder model AW, shock-mounted in a weatherproof metal box. To insure safe transporting, the entire unit is bolted to the floor of the trailer with shockproof motor mounts.

The power supply is mounted in an identical metal box together with a master timer and electric circuits. Special circuits for energizing the anemometer and wind vane were necessary to insure long battery life and ample current when all pens of the recorder were being used. The circuit design is a resistor-capacitator type and uses ten 3-volt batteries for power (fig. 2).

With this setup, wind direction can be recorded in code to eight directions of the compass by four pens of the recorder (fig. 3).

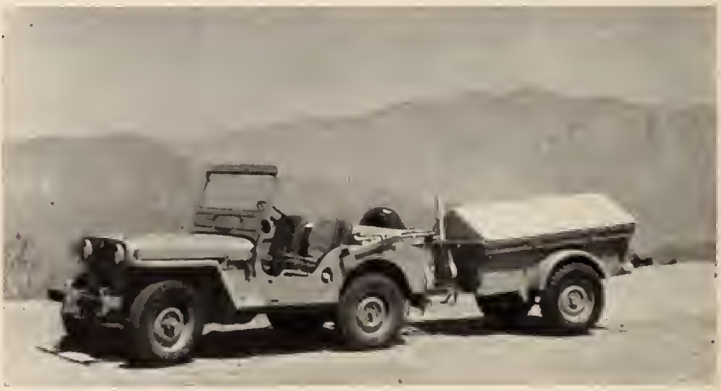

Figure 1.—Fireclimate survey trailer and jeep.

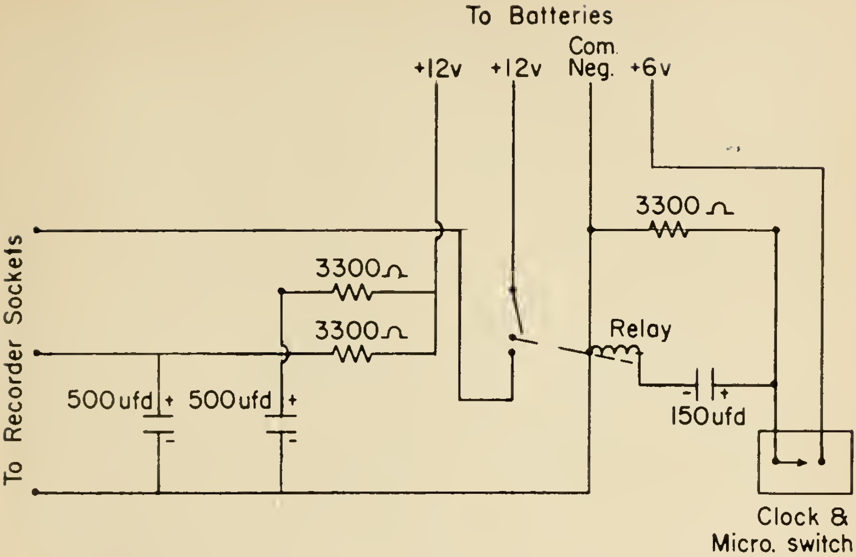

FIGURE 2.—Circuit for anemometer and wind vane.

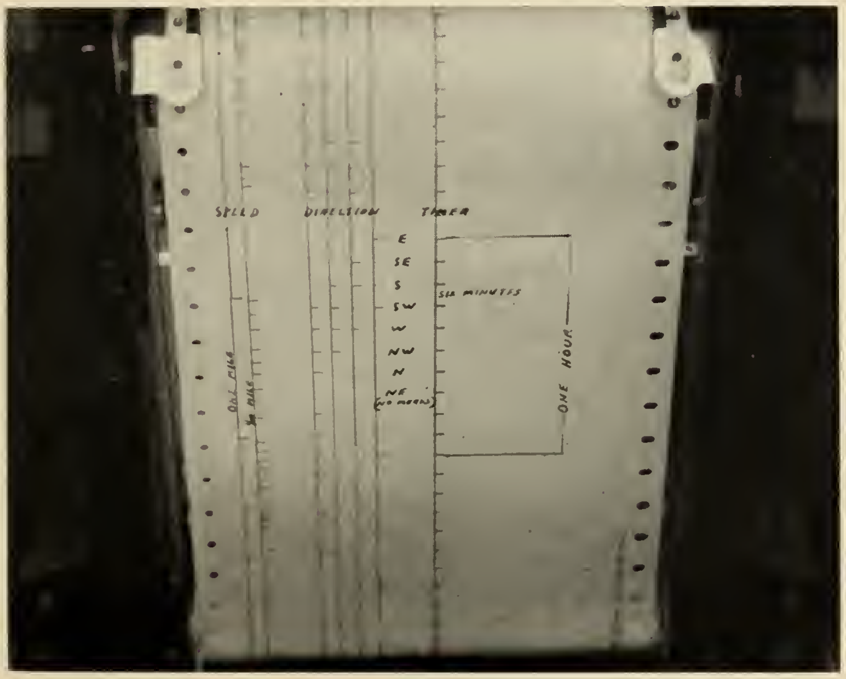

FIGURE 3.—Strip chart recorder showing record of wind speed, wind direction, and timer clock.

Wind direction is recorded every 6 minutes. To record eight directions with four pens, one direction must be coded to use no pens and hence leave no marks. Therefore the master timer is needed to verify that the recorder and other components were working when no mark was made. To do this job, a separate timing clock is connected to one pen of the recorder. The clock's microswitch also activates the wind vane circuit every 6 minutes. Wind speed is recorded by two pens, one marking each mile of wind and another each one-tenth mile.

Instruments carried in the trailer include wind vanes and anemometer, hygrothermograph, and fuel-moisture sticks and scale.

The wind vane, designed by the Forest Fire Research Division of the Pacific Southwest Station, has five silver-tipped contacts, one for each wind-direction pen on the recorder and a ground. The vane has proved both trouble- and maintenance-free during extensive field use. A small airways type anemometer is used.

The hygrothermograph is a standard Friez model with an 8-day clock. A padded, shockproof metal box mounted on the trailer floor provides safe and weatherproof transportation for the hygrothermograph, and for ½-inch fuel-moisture sticks and their wire supports and portable scales (fig. 4).

The instrument shelter was also designed especially for fire-climate surveys. It weighs only 18 pounds, is about 16 inches

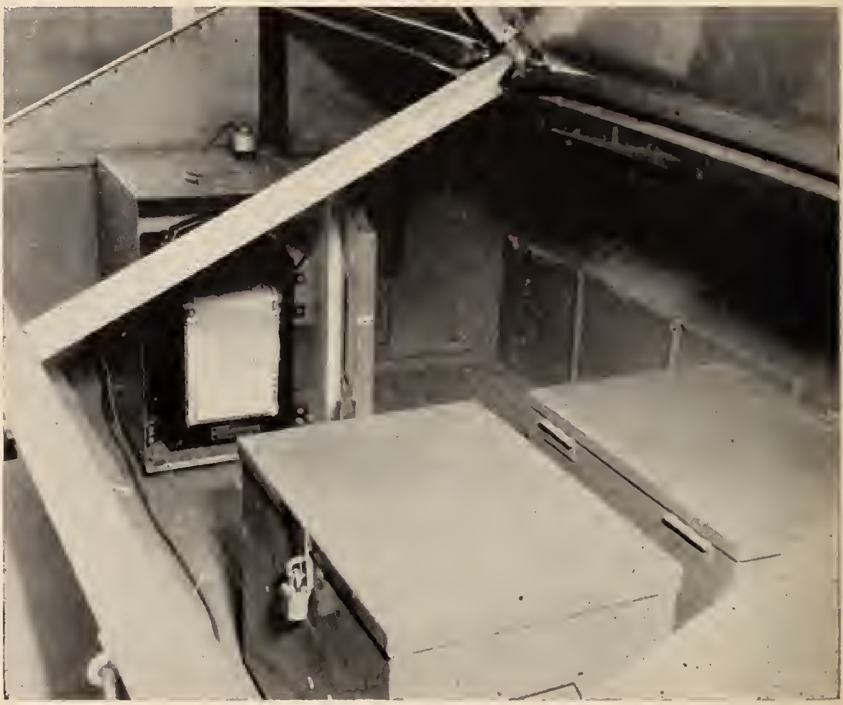

FIGURE 4.—Closeup of interior of trailer.

square, and is adapted for use with screw-on telescoping legs. In recent tests, temperature and relative humidity in the small shelter showed no appreciable difference from those in a standard shelter. Shelter and tripod legs are strapped to the trailer floor for transporting.

A 24-foot telescoping mast supports the anemometer and wind vane (fig. 5). Made of lightweight aluminum, the mast collapses to 6 feet. When extended, it can withstand winds of more than 100 miles per hour, without use of guy wires. The mast is mounted by sliding it into a 4-foot, 1 ¾-inch pipe welded to the trailer frame and body. Two tapped holes in the pipe sleeve take wing bolts which apply a light pressure on the mast to prevent it from twisting after the wind vane has been orientated.

The mobile unit has performed satisfactorily on three going fires and one fire investigation, and it has been a valuable aid to both the fire-weather forecaster and the fire behavior specialist.[1] All the instruments have undergone extensive field tests, some for more than 2 years. One installation gave more than 39,000 consecutive recorded observations over a 5-month period without major servicing. The unit performed well in temperatures ranging from 5° below zero in 24 inches of snow to over 114° above.

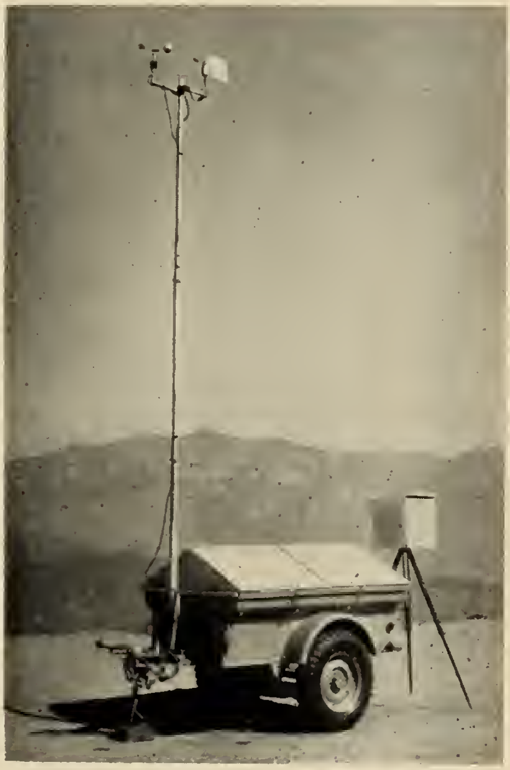

FIGURE 5.—The fireclimate survey trailer in operation.

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[1] C. C. Chandler and Clive M. Countryman. *Use of Fire Behavior Specialists Can Pay Off.* Fire Control Notes 20(4) : 130-132. 1959.

It withstood winds of 80 m.p.h. The only modification planned is to replace the aluminum cover with a fiberglass canopy which will be lighter, more easily waterproofed, and more easily mass produced.

The fireclimate survey trailer can operate in all types of weather, has low power requirements, and can be set up in less than half an hour and left in one location indefinitely. It needs checking only once every 8 days. It compiles and maintains legible and accurate records of wind speed and direction, relative humidity, and temperature. There is ample room to carry other instruments.

REDUCTION OF FUEL ACCUMULATIONS WITH FIRE[1]

ROBERT M. ROMANCIER
Forester, Southeastern Forest Experiment Station

Prescribed burning has often been used to reduce fuel accumulations, but only rarely has specific information been gathered to determine the effectiveness of a burning program. A 4-year study on the Camp Experimental Forest[2] in Sussex County, Virginia, provides a measure of the effects of repeated prescribed burns on the depth and character of the forest floor. The objectives of the burning program were seedbed preparation, fuel reduction, and the control of understory vegetation.

The stand used in this study consisted mainly of 60-year-old loblolly pine (*Pinus taeda* L.) in mixture with blackgum (*Nyssa sylvatica* Marsh.), red maple (*Acer rubrum* L.), and a scattering of various oaks. The average basal area per acre was 120 square feet for the pine and 35 square feet for the hardwoods.

Initially the very abundant shrub layer, composed mostly of Clethra and Vaccinium, had an average height of about 2½ feet. It probably would have prevented adequate pine regeneration after harvest unless reduced by some special treatment.

Below the dense shrub layer was a heavy accumulation of litter. Measurements of the litter depth and shrub height were taken before each fire (table 1). The average fuel accumulation was 4.8 inches deep and consisted of normal forest leaf and twig fall, along with larger pieces of wood, stumps, down trees, and other woody material. According to Metz, the average annual litter fall from such a stand is slightly more than 2 tons per acre.[3]

The stand was located on two soil types: Fallsington very fine sandy loam and Othello very fine sandy loam, about equally represented. These soils have very poor drainage; water stands on the Othello most of the year. Under such conditions, normal decomposition is greatly retarded, resulting in an excessive buildup of litter and in the development of an A_0 horizon. This horizon consists of partially decomposed organic matter and contains many small leaf pieces and roots.

The A_0 horizon or mat is usually very moist and is not ignited by the ordinary prescribed burn, except when a stump or log catches fire, thus drying out the mat around it. Then a slow, smoldering ground fire is started that is very difficult to extinguish short of flooding or trenching to mineral soil. When exposed by fire or other disturbances, the residual mat forms a very good seedbed.

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[1] This article was presented as Southeastern Forest Experiment Station Research Notes 143 in April 1960.

[2] Maintained in cooperation with Union Bag-Camp Paper Corporation, Franklin, Va.

[3] Metz, Louis J. *Calcium content of hardwood litter four times that from pine; nitrogen double.* U. S. Forest Serv. Southeast. Forest Expt. Sta. Res. Notes 14. 1952.

The study area was composed of four 40-acre compartments. One compartment was not burned, and served as a control. The others received a winter burn, and then one, two, and three summer burns respectively.

The winter fires served to create more uniform conditions within each compartment, and were considered as a preparation for the summer burns to follow. These winter fires reduced the height and density of the low hardwoods and facilitated wind movement through the stands.

The summer fires, in June or July, did the heavy work of fuel reduction, control of understory vegetation, and seedbed preparation. Most of the study area was burned by head fires, although backfires were frequently used to prevent breakovers into unburned areas.

The weather characteristics were very similar for all of the summer fires. The burning index was 4 or 5,[4] the relative humidity was close to 50 percent each time, and the air temperature between 84° and 92° F. The fuel moisture ranged between 5.6 and 7.6 percent. Winds were westerly, with velocities usually close to 2 to 4 m.p.h. measured at 8 feet above the ground.

At the end of the burning program, samples of organic matter were collected, weighed, and separated into their woody and litter components. Subsamples of woody and litter fuel were ovendried and a conversion factor obtained so that the dry weights could be expressed as tons per acre of dry fuel.

The results revealed that each fire caused a considerable reduction in the depth of the litter and in the average height of the shrub layer. A fuel reduction of 9.1 tons per acre resulted following a winter and one summer burn (table 2). Two additional summer fires removed another 5 tons of fuel per acre. The most surprising fact revealed by this study was the very high initial fuel weight of 36 tons per acre. This concentration can best be explained by the wet, poorly drained site and heavy stand of trees and lesser vegetation.

Supplementary samples were taken to determine the relative amounts of the readily flammable upper layer of litter and of the less flammable lower layers. The first series of fires (one winter, one summer) caused considerable change in the composition of the fuel; subsequent fires seem to have had little effect upon the relative amounts of the two fuel types (table 3).

This study points out that on Fallsington and Othello very fine sandy loam soils, fuel accretion comes not just from leaf and twig fall, but also from below. The dark mat of partially decomposed organic matter that develops under such conditions dries out and fluffs up following a fire in the litter above, and is capable of sustaining a fire within a short time.

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[4] Type 8-0 Fire Meter

TABLE 1.—*Average litter depth and shrub height before each fire*

Time of measurement	Litter depth	Shrub height
	Inches	*Inches*
Before the winter fire	4.8 ± 0.6	29.3 ± 4.6
Before first summer fire	3.0 ± .4	14.8 ± 1.7
Before second summer fire	2.5 ± .3	8.3 ± 1.3
Before third summer fire	1.8 ± .4	6.0 ± 1.4

TABLE 2.—*Fuel per acre remaining following treatments*

Treatment	Litter	Woody fuel	Total fuel
	Tons	*Tons*	*Tons*
Unburned control	32.8	3.3	36.1
One winter and one summer fire	24.4	2.6	27.0
One winter and two summer fires	21.8	1.7	23.5
One winter and three summer fires	20.5	1.6	22.1
Total reduction	12.3	1.7	14.0

TABLE 3.—*Proportion of fuel by litter layers following treatment*

Treatment	Upper layer of litter	Lower layer of litter
	Percent	*Percent*
Unburned control	23.5	76.5
One winter and one summer fire	13.1	86.9
One winter and two summer fires	16.5	83.5
One winter and three summer fires	14.6	85.4

SCORCH AND MORTALITY AFTER A SUMMER BURN IN LOBLOLLY PINE[1]

PETER H. ALLEN
Forester, Southeastern Forest Experiment Station

Foresters who use prescribed fires in loblolly pine management are concerned with damage to trees in hotspots. A 5-acre hotspot developed during a prescribed summer fire on the Camp Experimental Forest[2] and gave us an opportunity to evaluate pine and hardwood mortality after the crowns were severely scorched. Most healthy loblolly pine survived despite severe needle kill, and the fire-killed timber could have been salvaged in harvest operations.

The fire, made to evaluate the reduction of hardwood competition and litter for seedbed preparation, was the first summer fire after an initial fuel-reduction burn two winters before. At 1:00 p.m. on the day of the fire the northwest wind at a weather station in the forest was less than 5 m.p.h., the air temperature was 80° F., the relative humidity was 50 percent, and the fuel moisture content was 4.7 percent. The hotspot was the result of poor firing technique; in haste to complete the work, workers strung lines of fire on all sides. Where the fires converged, the intense heat severely scorched the crowns of the 60-year-old loblolly pine.

The amount of needle scorch 3 weeks after the fire and mortality 1 year later are shown in table 1. Sixty-five percent of the pines 5 inches d.b.h. and larger were severely scorched, with needle kill in more than two-thirds of the crown. The trees 5 to 8 inches in diameter, in the lower crown position, were most severely scorched. Mortality was greatest among these least vigorous trees; survival increased with size. Of the pines larger than 8 inches, only 10 out of 404, or 2 percent, were killed.

The hardwoods were generally more susceptible to fire injury than pine. Survival differences are apparent among the hardwood species (table 2). American holly, white oak, and other oaks (principally southern red, black, and post) were most susceptible. Sweetgum and red maple were more fire resistant, while blackgum was least damaged. Mortality differences by tree size were not as great as in pines, and 12 out of 19, or 63 percent, of the hardwoods larger than 8 inches were killed.

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[1] This article was presented as Southeastern Forest Experiment Station Research Notes 144 in May 1960.

[2] Maintained in southeastern Virginia by the Southeastern Forest Experiment Station with the cooperation of the Union Bag-Camp Paper Corporation, Franklin, Va.

TABLE 1—*Crown scorch and 1-year mortality of loblolly pine in a 5-acre hotspot*

Diameter class (inches)	Trees severely crown scorched	Mortality
	Percent	*Percent*
5	87	48
6	76	34
7	73	20
8	58	8
9	64	5
10	51	0
11	54	6
12	47	0
13+	37	4
Average all diameter classes	65	21

TABLE 2.—*Hardwood top kill 1 year after burning*

Species	Total stems		Dead		Mortality
	Number	Average d.b.h.	Number	Average d.b.h.	
		Inches		*Inches*	*Percent*
White oak	34	6.6	26	6.8	76
Other oaks	34	6.6	26	6.6	76
Holly	35	7.4	26	6.7	74
Sweetgum	26	6.0	12	5.8	46
Red maple	27	7.8	12	7.0	44
Sourwood	3	6.6	1	5.0	33
Blackgum	42	7.5	9	6.7	21

LEAD PLANE TECHNIQUES IN AIR TANKER ATTACK

[Excerpts from a Forest Service paper given at the Air-Ground Coordination Workshop, Boise, Idaho, January 25-29, 1960]

The question is often asked, particularly by persons who have never observed air tanker operations, "Why is a lead plane necessary?" Any type of fire suppression action requires direction and supervision to gain the most benefit from the tools and manpower being used, in this case the aerial tanker. It is the primary purpose of the lead plane to remain over the fire, observe its course and behavior, and determine the action to be taken. Then the target must be positively identified to insure that the tanker's load of retardant is not wasted.

The lead plane pilot should be alert at all times for unsafe practices or conditions. Tanker pilots are sometimes tempted to fly under conditions approaching marginal. It is the responsibility of the lead plane pilot to test the air for turbulence, to observe and report snags or topographical hazards, plan the approach and escape routes, and evaluate visibility. The lead plane pilot should have experience in making actual drops so he can recognize, at the earliest moment, the beginning of an unsafe or poor pass. It is possible, with experience, to judge the airspeed of a drop plane within 5 knots.

An experienced lead plane pilot is invaluable in breaking in and qualifying new tanker pilots. The technique employed is to brief the pilot on the target and make a pass with the lead plane so that he can observe your run. Then pull around and fly formation with him, talking him through the entire maneuver. You must direct every step of the operation over the fire, and be merciless when any maneuver contrary to safe operation is observed. Tendencies to "show-boat" or take unnecessary risks must be stopped.

A written report of each drop should be kept and a critique held with all concerned. This reporting is also a requisite to evaluation of air tankers.

Many different makes and types of airplanes have been used for lead planes and all have had undesirable features. A lead plane should have the following characteristics:

1. High speed enroute to the fire.
2. Low speed for circling at the fire.
3. Unimpared visibility.
4. Structural integrity.
5. Low fuel consumption and large fuel capacity.
6. Low maintenance.
7. Low acquisition cost.
8. Adaptability to other uses.

Personal preference enters into any discussion of aircraft, but there are certain basic things to keep in mind. A high wing airplane offers the best visibility as long as the airplane is straight and level; however, when turning, the wing interferes with visibility. The low wing airplane has the best configuration for a lead plane, particularly when used at low altitude. Speed range is another desirable attribute in a lead plane, high cruise speed in going to the fire and low stall speeds to permit slow turns over the fire and require less turning radius. Tandem seating has advantages as it permits both the pilot and the air attack boss to keep the target in sight, provides unrestricted visibility in turns to the right, as well as to the left.

Two lead plane techniques have been used. The first technique is where the lead plane circles at approximately 1,000 feet at the fire and directs the air tankers by radio. The advantages of this system are better visibility and less hazard to the lead plane. The second technique is the low-level, "show-me" method wherein the lead plane simulates the tanker pass and identifies the target both by radio and by rocking his wings over the target. Under this system the lead plane prescribes the attack and escape routes, and supervises the drop plane through all phases of the operation.

It is immediately apparent that there are certain prerequisites to performing capably as a low-level lead plane pilot. He should be a skilled, competent, and confident pilot and an experienced tanker pilot. He should have a working knowledge of fire behavior and suppression. Tanker experience is needed so he will know when a target is marginal, or when a tanker is commencing a potentially hazardous pass. Experience will also enable him to judge the airspeed of the tanker and evaluate the drop. It is desirable that the lead plane pilot have experience in all types of aircraft being used for tankers.

Tanker pilots who have dropped borate under both types of lead systems have expressed preference for the low-level method. As long as they keep the lead plane in view, they have a reference for terrain clearance and airspeed, and are relieved of the responsibility of initial identification of the target.

The air attack boss can be of great value. He directs the lead plane pilot in planning the attack and selecting targets. But the direction of the tankers and the final decision on the feasibility of the target remains the responsibility of the lead plane pilot.

Attack procedures start when the lead plane pilot reports to the base in the morning. At this time he thoroughly pre-flights the aircraft, warms up and checks the engine, and performs a full radio equipment check. It is the responsibility of the lead plane pilot to make sure that he has the necessary maps and charts for his area of responsibility. By maintaining a listening watch, he can determine which tankers are airborne. A low-level circle is made to determine how and where to make the attack, to observe the condition of the air, visibility, the path of attack and escape, the minimum altitude over the target and hazards such as snags, wires, or other obstructions. At this time careful note will be taken of the presence and location of any personnel on the fire.

The tanker planes will start calling in on air net when approximately 5 minutes from the fire. At that time the lead plane pilot can tell them the specific location on the fire where they are to drop, and the general altitude at which they will work. As the tanker approaches the fire, the lead plane is positioned to make a dry run that the tanker can observe. As the lead plane arrives over the target, the pilot rocks the wings, at the same time telling the tanker over the radio, "Here." Immediately after passing over the drop spot, the lead plane breaks off the pass in a level turn, if possible, so that the results of the drop can be observed. Generally, by the time the first tanker is dropping, other tankers have arrived over the fire and are able to observe the preceding drop. The tankers should be kept in a circle above the lead plane. This permits them to observe the drops and get an idea of what the attack is trying to accomplish. It also adds to safety as it enables the tanker pilots to keep each other in view. Many tankers are blind on turns to the right, and whenever possible, a left hand pattern should be established.

The lead plane must be constantly alert for propellor wash from the tankers, and blowups on the fire which can bring severe to extreme turbulence. High speed passes by both lead plane and tankers can impose "G" loads in excess of the structural limitations of the airplanes, particularly when they are heavily loaded, and accuracy and effectiveness fall off with increases in speed. The lead plane should stay in the immediate vicinity of the target for safety and, for good handling of the tankers, stay in the drainage being worked.

Good communications are very important. All transmissions must be made in a calm, clear manner; speech must be slow and distinct. In case of radio failure while using the low-level lead plane system, it is possible to pull up and fly formation with the tanker to gain his attention, then make the regular pass, rocking the wings over the target. The lead plane must not leave the fire until relieved or the tankers have stopped coming. The communications chain must be strictly adhered to to prevent confusion and misunderstanding.

In the case of two fires in close proximity, utilizing one or more air atack bases, or one fire using two or more bases, or a large campaign fire where a divided attack using two lead planes is waged, communication is the most important single factor. A chain of communication and command must be set up prior to the dispatch of the first airplane and must be adhered to without deviation.

AIR TANKER CAPABILITIES AND OPERATIONAL LIMITATIONS

[Excerpts from a Forest Service paper given at the Air-Ground Coordination Workshop, Boise, Idaho, January 25-29, 1960]

The U.S. Forest Service started operational use of air tankers in 1956. During that year, small aircraft with about 100-gallon capacity dropped 124,000 gallons of fire retardants and suppressants. Use of air tankers has increased to the point where a large variety of tankers, some having capacities of 3000 gallons, dropped almost 3.5 million gallons in 1959. With this rapidly expanding use of air tankers, there is need for more detailed attention to the effectiveness, efficiency, and safety of the entire operation. Study and training in aircraft capabilities and operational limitations is a vital part of this.

The Federal Aviation Agency sets the minimum requirements for pilot qualifications and aircraft airworthiness. There are certain limiting factors that must be recognized and considered: (1) Pilot ability, (2) aircraft capabilities, and (3) operational limitations.

PILOT ABILITY

Pilot ability does not affect the capabilities built into the aircraft, but it does have an important bearing upon the operational limitations of the aircraft. Basically pilot ability can be summed up by three things: Planning, judgment, technique.

Experience contributes greatly to pilot ability. Air tanker pilots should have experience in low-level flying in heavy aircraft over typical terrain and under adverse conditions.

AIRCRAFT CAPABILITIES

Air tankers should have good load carrying capacity, good air speed, and be fairly maneuverable under loaded conditions. Today's airplanes are designed either for high speed or high load capacity.

The old Fairchild 71, Travel Air, and Ford Trimotor planes have wing areas of 270 to 310 square feet for the single engine models and up to 835 square feet for the trimotors. The thickness or camber of the wings on these planes were designed for high lift with good maneuverability, but not for high speed.

There is not an airplane being built today by United States manufacturers that can duplicate the load carrying capacity and slow flight maneuverability that enable these planes to land and take off from rough unimproved mountain meadows. But due to distance, low speed, and small load capacity, these old planes are not satisfactory for most air tanker work. For these reasons, flight operators have turned to large military surplus aircraft as these planes are about the only ones available that can be adapted to air tanker work.

It is known that maneuverability becomes more restricted as speed and wing loading increase. Because of this, many multiengine aircraft available today approach the limits for efficient and safe operation, particularly in mountainous terrain. As a result, maneuverability is a factor that must be considered in selecting suitable aircraft.

As the weight of aircraft increases, stall speeds increase. This affects landing and is accentuated in turns; the greater the degree of bank, the higher the stall speed. The safety factor may become critical when aircraft are operated at maximum weights. The reduced maneuverability in turns is more pronounced for low load factor airplanes (maximum load).

Whenever adjusted gross weight is increased above the designed gross weight, the load factor which can be reached in flight must be proportionately reduced. In general, the higher the original design load factor of the airplane, the greater the possible weight increase. The load factor, however, cannot be reduced below a certain limit because of structural strength.

The rough, turbulent air generally associated with forest fires can impose overload stress on the aircraft beyond that for which it was designed, particularly during maneuvers while carrying maximum loads of retardants. The danger of this is more easily recognized if a comparison is drawn between the heavily loaded aircraft in tight maneuvers and an overloaded pickup on rough roads. Something is bound to give in either case unless the loads are lightened or maneuvering or driving is restricted.

OPERATIONAL LIMITATIONS

Airplanes operating near the ground, as in air tanker work, have an additional hazard if strong or gusty winds are encountered. This can be caused by normal orographic lifting of an air mass around most ridges, mountains, and canyons, an unstable air mass causing cumulus cloud activity, or rising heated air from a hot rolling fire.

The conditions can become critical. For example, a tanker plane being positioned and slowed for a drop run can encounter a strong gust of wind striking only one side of the airplane. This gust can destroy the lift of that wing by disrupting the flow of air over it, causing the plane to roll toward that wing with a loss of altitude. This could be disastrous on low-level flights. All personnel involved should be constantly alert to dangerous atmospheric conditions.

Pilots must be aware of what to expect when operating near or around thunderhead type clouds. They must be able to analyze quickly the type of thunderhead, its stage, whether it is building, mature, or dissipating, and what to expect in surface effect. They should also be able to make a quick decision of whether to continue flying or to get back on the ground. This is true for all adverse atmospheric conditions, contributing to visibility or turbulence.

The performance of aircraft is also affected by density altitude as determined by temperature and atmospheric pressure (pressure altitude). For each increase of 9° F., or 5° C., above standard (59° F., or 15° C.), the density altitude change is 550 feet.

SUMMARY

Efficient and safe air tanker operations are dependent in a large degree upon aircraft capabilities and operational limitations. With ever-increasing types and numbers of air tankers, particularly the large, fast, military-type aircraft, it is important that the basic capabilities of each type is known and that this knowledge is applied in planning and operation. Operational limitations, as affected by pilot ability, weather conditions, and topography must also be recognized.

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Fire Risk From Road Project Flares

The use of flambeaux (oil flares) to illuminate road construction warning signs is a cause of fires in forested areas. On several occasions we have found these signs partially burned because of their being blown across a lighted flambeau. Where flammable vegetation extends within reach, the risk is obvious. The risk can be eliminated by substituting portable electric lighting.

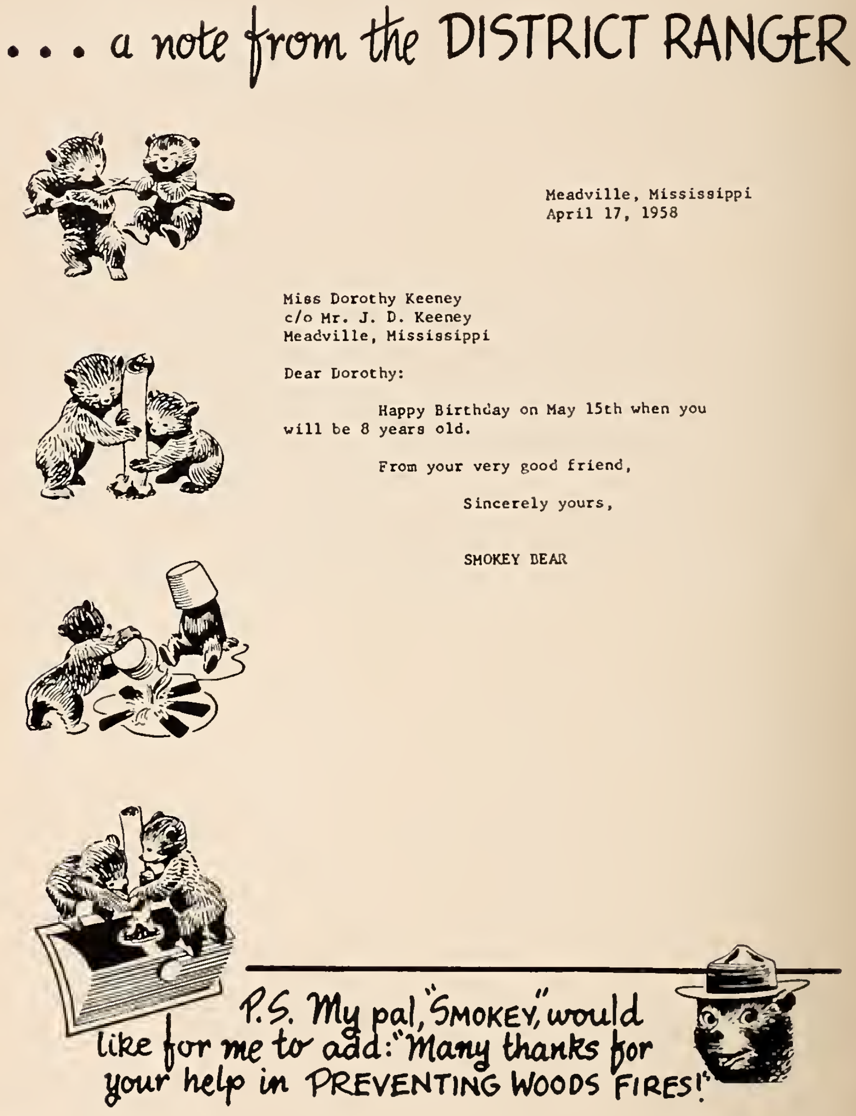
Battery-powered, transistorized flashers are being used by many road construction and maintenance organizations. The flashes are brief but readily seen at night. Cost is $13 plus two batteries at $0.65 each. Since battery life is 800 to 1800 hours, overall cost is small. Bulb cost is negligible. These flashers require much less servicing than do flares.

The savings that are possible plus the elimination of the fire risk should promote the use of transistorized flashers by more road construction and maintenance men.—CLIFFORD R. FAULKNER, *District Ranger, Pisgah National Forest.*

PUBLICIZING SMOKEY BEAR FIRE PREVENTION

Ranger John O. Kirby, U. S. Forest Service, Southern Region, has attempted to capitalize on Smokey Bear at a local, more personal level. Following are three ways in which this was done:

1. All children in Franklin County between the ages of 5 and 10 received personal birthday greetings from Smokey. Some children wrote a thank you to Smokey. In preparation for this program, the



. . . a note from the DISTRICT RANGER

Meadville, Mississippi
April 17, 1958

Miss Dorothy Keeney
c/o Mr. J. D. Keeney
Meadville, Mississippi

Dear Dorothy:

Happy Birthday on May 15th when you will be 8 years old.

From your very good friend,

Sincerely yours,

SMOKEY BEAR

P.S. My pal, "SMOKEY," would like for me to add: "Many thanks for your help in PREVENTING WOODS FIRES!"

superintendent of schools was contacted and a list of children in this age bracket was secured and copied on cards. These cards were then sorted and indexed by birthdays. Three days prior to the birthday a standard greeting letter was mailed. Children who wrote back to Smokey received an additional packet of fire prevention literature.

2. Local announcements informed the public that children would receive a Junior Forest Ranger badge if they wrote Smokey (in care of the local District Ranger) telling Smokey why they

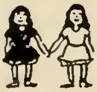
The two little bears...

Two little bears-hunting things to do-
Found a glowing matchstick,
And broke it right in two!

Two little bears-roaming through a wood-
Saw a burning cigarette,
And crushed it out good!

Two little bears-and a camping fire left smoking-
Made sure the embers were dead out,
By giving them a soaking!

Two little bears-think ashtrays used in cars-
Will help keep our forests green
And free from ugly scars!

CAN OR  DO LESS THAN ?

think he should make them Junior Forest Rangers and what they had done to prevent forest fires. There was enthusiastic response, letters were interesting and, in some cases, helpful in appraising the local fire prevention effort.

3. A local bank furnished the District Ranger a month's supply of their statement envelopes. Smokey Bear stamps were affixed to the envelopes and returned to the bank. This same procedure was followed for the monthly statements of large business concerns in the vicinity.

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INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

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SMOKEY
never burn trash or
debris on dry
windy days
remember:
ONLY YOU CAN PREVENT FOREST FIRES!

VOL. 21 JULY 1960 No. 3

7/5/60

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

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FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 21 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (October 17, 1958).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1960

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LIGHTNING PROBABILITY FORECAST

HOWARD E. GRAHAM
Meteorologist, Division of Fire Control, Region 6
U. S. Forest Service

INTRODUCTION

A probability concept was used for forecasts of lightning occurrence during the 1959 fire season for western and central Oregon national forests. This article deals with an evaluation of these forecasts, some of the problems of weather prediction and the basic need for a statement in each forecast of the likelihood for certain weather events to occur. It is pointed out that probability statements in forecasts are meaningful.

Weather forecasts are traditionally written as categorical statements. This is done in spite of the fact that whether or not uncertainty is expressed, uncertainty as to outcome exists with every weather forecast. Increased precision in forecasting is expected to come with advances in the meteorological science. However, our increased ability to observe and analyze the atmosphere is not always accompanied by a corresponding improvement in the skill with which we are able to predict future weather. Because of the importance of weather to fire control activities, it is important that efforts be made to advance the usefulness of weather forecasts within the existing state of weather forecasting accuracy. For this purpose, we will examine the nature and quality of probability estimates of future weather.

FORECAST UNCERTAINTY

Every forecast is accompanied by an error distribution. This error distribution exists for the categorical forecast, for the forecast where the error distribution is merely implied and in a probability forecast where the error distribution is clearly stated.[1] The error distribution exists for several reasons. Some of these reasons are—

1. The atmospheric sampling procedures are crude and provide only a qualitative measure of the small-scale factors which make up the real atmosphere.
2. The atmospheric processes are very complex. The complexity is so great that the mathematics of the prediction problem currently exceed our technical ability for exact solution.
3. There are unknown external influences such as variable solar activity.

FORECAST USEFULNESS

In order that weather forecasts may be fully utilized in operational decisions, it is necessary first that the degree of forecast uncertainty be known.[2] A second, and probably equally important aspect, involves developing a systematic means for applying the degree of forecast error distribution in making the operational decision.

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[1] Malone, Thomas F. *Applied Meteorology.* Meteorological Res. Rev. 3 (16). July 1957.

The categorical forecast essentially leaves the operational decision up to the weather forecaster. The probability forecast leaves the operational decision to the user. The latter is the more economically sound procedure, providing the user has accounted for both the forecast uncertainty and the operational risks. The manner in which weather forecasts are applied to a fire control decision must be determined by the forecast that is possible to make.

PROBABILITY FORECASTS

Evaluation.—There are guides to accuracy of probability statements. First, the forecast probabilities should agree reasonably well with the observed relative frequencies. This is called forecast "reliability."[3] For example; when forecast probabilities of 75 percent are made for occurrence of some weather event, this event should be observed about three out of every four times that the forecast was made. A second desirable characteristic of probability forecasts would be for a large percentage to be near certainty (yes or no).[4] This is called "resolution."

Reliability.—There have been several tests which show the feasibility of probability estimates by weather forecasters. Williams[5] pointed out that forecasters at Salt Lake City could indicate fairly well on an average whether or not their forecasts would verify. Weather forecasters at San Francisco[6] have issued probability forecasts of rain for public use. During the first winter's experience, these forecasters were overconfident on the higher probabilities. During the following winter, with more experience, the forecasts closely approached perfect reliability. There was likewise a tendency, during the second year, to increase the near "yes" and near "no" predictions. Fire-weather forecasters at Chicago[7] demonstrated that forecasters there could evaluate the chance of occurrence of tested weather elements.

---

[2] Thompson, J. C. *The Nature of Weather Forecasting Decisions.* U. S. Weather Bureau, Office of Meteorological Research. Unpublished.

[3] Sanders, Fredrick. *The Evaluation of Subjective Probability Forecasts.* Mass. Inst. Technol. Dept. Meteorology Sci. Rpt. 5. June 1958.

[4] Brier, Glen W. *Verification of Forecasts Expressed in Terms of Probability.* U. S. Monthly Weather Rev. 78. Jan. 1950.

[5] Williams, Phillip W. *The Use of Confidence Factors in Forecasting.* Amer. Meteorological Soc. Bul. 32 (8). Oct. 1951.

[6] Root, Halbert E. *An Evaluation of Probability Forecasts for the San Francisco Bay Area.* Unpublished. July 1958.

[7] Schroeder, Mark J. *Verification of 'Probability' Fire-Weather Forecasts.* U. S. Monthly Weather Rev. 82 (9). Sept. 1954.

FIRE-WEATHER LIGHTNING PROBABILITY FORECASTS

Procedure.—During the 1959 fire season, fire-weather forecasters at Portland, Oreg., issued routine probability forecasts of lightning occurrence for selected national-forest areas in Oregon. The forecast probability of lightning was the forecaster's estimate of the chance for the forecast to verify. These estimates were based on individual forecaster's judgment with little or no reliance on statistically based procedures.

Interpretation of graphs.—The results are illustrated in figures 1 and 2. In these figures the forecast probability is plotted against the observed percent of occurrence; for example, the Mt. Hood graph shows ten forecasts made for 20 percent probability with an observed occurrence of 20 percent because two lightning-storm days occurred out of these ten forecasts. The condition where the forecast probability equals the observed relative frequency (perfect reliability) is indicated by the dashed diagonal lines. Forecaster overconfidence is shown when points fall to the right of the diagonal line, and underconfidence by the points to the left. The significance of points is dependent on the number of cases; for example, in the Willamette graph, there is some significance in the fourteen forecasts of 40 percent probability but practically none in the location of the one forecast of 70 percent probability. The majority of forecasts plotted in the figures as 10 percent probability were actually stated in the forecasts as 10 percent or less. In every figure, this would mean that the data plotted as 10 percent should lie some place to the left and nearer to the line of perfect reliability.

Forecasts.—The forecasts for most of the national-forest areas show that the forecasters were usually able to estimate the chance of lightning occurrence. There was, however, a wide scattering of results. The Umpqua National Forest forecasts generally expressed overconfidence of lightning. The forecasts for the Fremont National Forest (fig. 2) indicated the best reliability. Forecasts for the Siskiyou National Forest had very limited reliability. The average of all forecasts somewhat closely approximates perfect reliability. Overconfidence is shown for the 40 and 70 percent forecast probabilities. The 17 cases indicated as 90 percent probability were actually categorical forecasts where it is not known whether the forecaster overlooked the probability statement or was fairly certain. A categorical forecast of lightning implies from 80 to 100 percent probability. A larger percentage of forecasts near unity (yes) would have been a desirable characteristic. How did they score numerically? Based on a possible score (resolution) of zero for perfect forecasting and a maximum value of 2 for the worst possible forecasting,[5] the sample scores ranged from

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[5] See footnote 4.

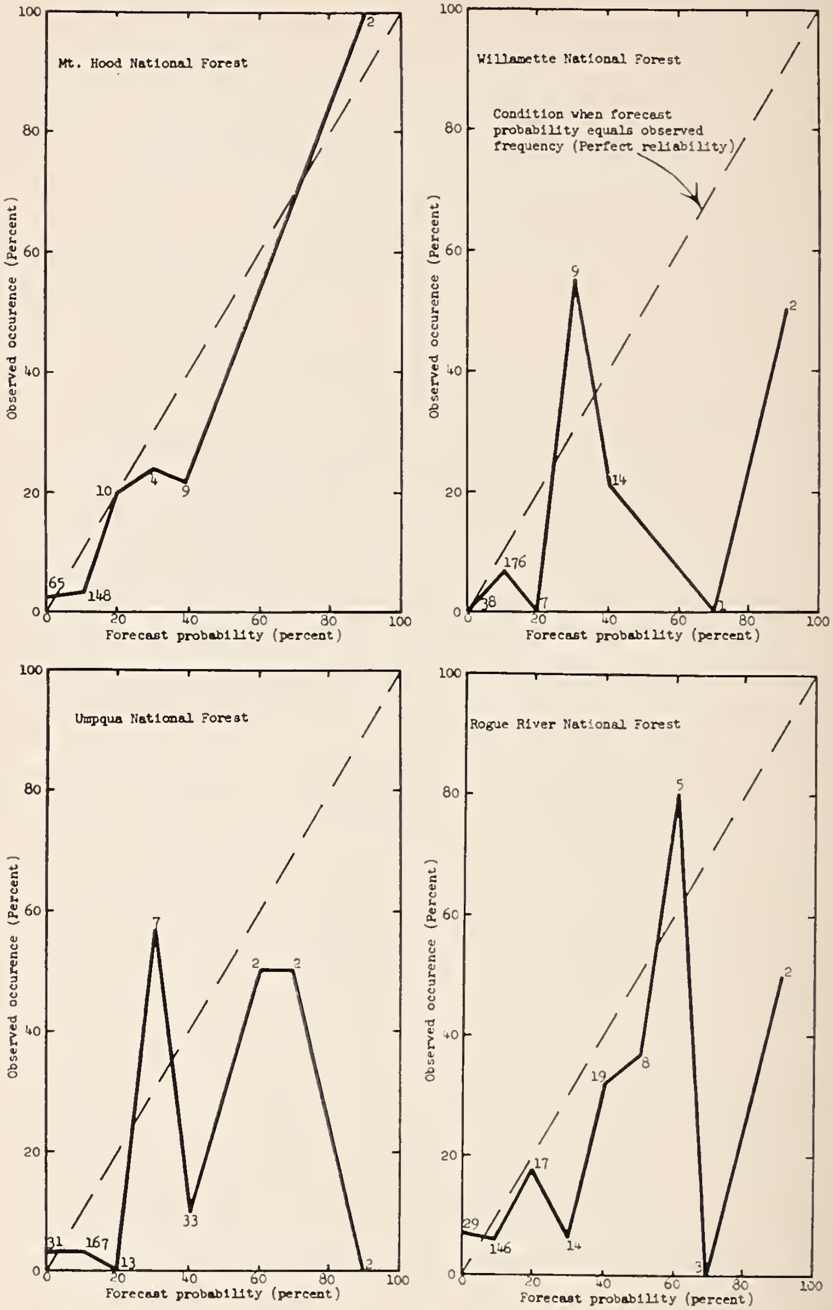

FIGURE 1.—Lightning probability forecasts July 11-September 30, 1959, for Mt. Hood, Willamette, Umpqua, and Rogue River National Forests. Numbers by points show all a.m. and p.m. forecasts.

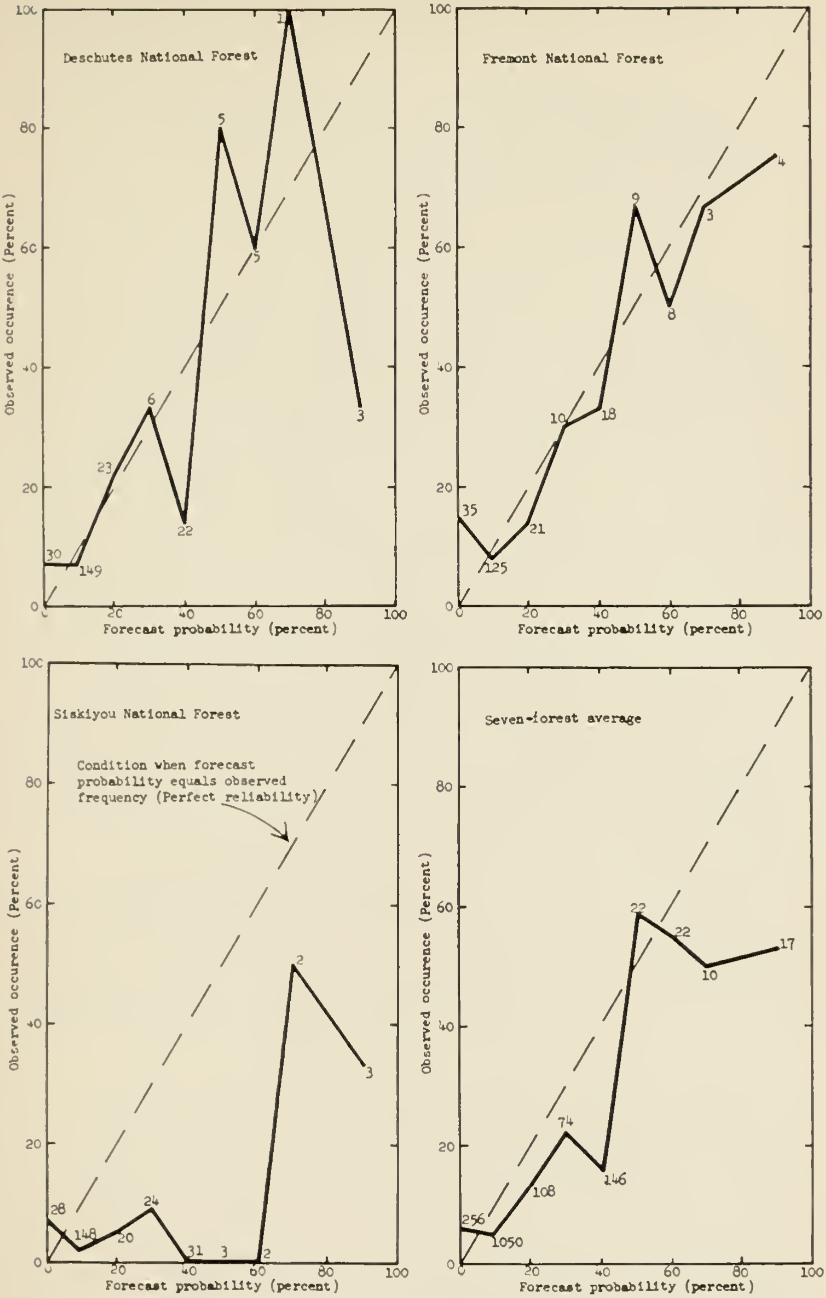

FIGURE 2.—Lightning probability forecasts July 11-September 30, 1959, for Deschutes, Fremont, and Siskiyou National Forests, and the seven-forest average. Numbers by points show all a.m. and p.m. forecasts.

0.12 to 0.28. Scores for sample national forests for the 81 forecasts during 1959, stated in terms of probability are as follows:

	Forecasts for tomorrow made at—	
	0825 P.S.T.	*1505 P.S.T.*
Willamette National Forest	0.17	0.14
Siskiyou National Forest	.12	.15
Deschutes National Forest	.21	.21
Fremont National Forest	.26	.28
Total	.76	.78

CONCLUSIONS

The inherent uncertainties in weather prediction may be given quantitative expression by the weather forecaster's use of the probability concept. A quantitative estimate of forecast uncertainty leaves the operational decision where it should be—with the user. From an appraisal of the forecast probability and the operational risk, there is then a logical basis for carrying out an operation.

The principal points of interest regarding probability factors with weather forecasts are these:

1. The increase in value over the use of traditional categorical forecasts depends directly on both the degree with which probabilities are concentrated toward the extreme (yes or no occurrence) and on the reliability or accuracy.

2. Experienced forecasters can prepare useful subjectively based probability forecasts.

3. The average of all forecasts issued by the Portland Fire-Weather Center shows that probability values were assigned that, on the average, agree fairly well with observed occurrence. This is in concurrence with other studies.

4. Forecasts for individual national forests were quite variable. Some were relatively reliable and some unreliable. Numerical scores show that forecasters have skill in recognizing departures from normal conditions.

5. Other studies have shown that forecaster's skill, in assigning quantitative probability estimates, can improve with experience. Foresters using probability forecasts should, therefore, expect improvement as the forecaster gains experience.

6. Assigning probability estimates of lightning occurrence has been improved in some instances by statistically developed forecasting procedures.[9] The poor results for the Siskiyou National Forest point up the definite need for research along this line.

---

[9] Price, Saul. *Thunderstorm Today? Try a Probability Forecast.* Weatherwise II, 2(3). June 1949.

Cramer, Owen P. *Preliminary Report: An Objective Method for Forecasting Thunderstorms for the Willamette National Forest.* U. S. Weather Bureau, Portland, Oreg. Unpublished. Jan. 1949.

A UNIFIED FIRE DANGER RATING SYSTEM BY 1963

A. A. Brown
Director, Division of Forest Fire Research, U. S. Forest Service[1]

All of you know of the project we have undertaken to unify fire danger ratings. It is a joint effort of the Divisions of Forest Fire Research, Forest Fire Control, and Cooperative Forest Fire Control in our Washington and field offices. I think you know too that John Keetch has been assigned the task of heading up this effort.

As State foresters you have a substantial stake in this project. Your fire control expenditures are now more than twice those incurred in the protection of Federal lands. On State and private lands east of the Mississippi, you have 250 fires per million acres compared with 70 fires per million on Federal lands. In the West the ratio is 63 fires on State and private lands compared with 29 on Federal lands. You now have 45 percent of the 3,000 fire danger stations that are maintained in the United States. The Forest Service has another 45 percent. Other Federal agencies and private organizations have the remaining 10 percent. Throughout the United States, a total of eight fire danger rating systems is in current use.

At this point we may ask ourselves why the use of fire danger rating systems has persisted and grown, and why we need to do something to unify them. The concept of rating fire danger was first developed by Harry Gisborne in the early 1930's. It was looked on at first as impractical and too ambitious. Yet even that rather crude rating system immediately became so useful to fire control managers that the idea caught on rapidly, and our forest experiment stations began adapting the system or developing one for local use. Throughout the ensuing 25 years, research in fire danger rating has continued to be a part of the program at most of our experiment stations. It has paid good returns, but overall progress in improving our systems had slowed down in the past 10 years.

In fire danger rating, we deal with two things—fire and environment. The response of fire to moisture, temperature, and wind is the same everywhere. But fuels, weather, and topography, which make up fire's environment, vary locally. Since in every national-forest region a regional system must of necessity reflect a variety of environments, a highly localized application is suggested as is a fixed accuracy up to some jurisdictional boundary. This is only where confusion begins. The regional systems vary too in the relative weights they give to wind, moisture, and temperature; in how they are expressed numerically; in how they are used; and in how they are interpreted.

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[1] From a paper presented at State Foresters Association Meeting Oct. 8-10, 1959, at Stowe, Vt.

As State foresters you are perhaps a little more fortunate than some Federal foresters, since in most instances you can use a single regional system statewide. But if you are not satisfied with it you find it awkward to change. The Bureau of Land Management finds itself in the predicament of deciding which of eight danger rating systems will best serve their purpose in the widely scattered lands for which they are responsible. The Park Service has the same problem. In Research, we have concluded that further work on refining and adapting regional systems is too time consuming and not likely to be productive. We hope to develop a basic system that will treat universal relationships in a uniform way and yet be flexible enough to take local environment into account.

In starting the job last year, John Keetch visited each Forest Service regional office and experiment station to study the status of fire danger ratings and their uses. The purpose was to make a comparative analysis of the basis on which each danger rating system had been developed, and to find the reasons for the weights that were used. At the regional offices, a study was made of how fire danger ratings are used by the fire agencies in each region, and of how well the users felt the ratings were serving their intended purpose. In making this study, Keetch talked to a great many State foresters or their representatives in California, Oregon, Washington, and the Northeastern States. In the Lake States and the States in Region 7, State foresters supplied memos to Regional Foresters on what they felt was needed. In other Forest Service regions, the Division of Cooperative Fire Control supplied similar information.

Following these studies, Keetch made a careful analysis of each of the fire danger rating systems, and he has made several numerical comparisons of his findings. Progress reports from this study were distributed to all Forest Service regions and experiment stations with circular letters on March 16 and August 28 this year. Agreement is reached on giving weight to wind speed and to some measure of flammability, but there is no agreement on what "flammability" means nor on how to determine the best measure of moisture content of fuels. This last point is perhaps the most critical one that must be settled before we can reconcile the many other points of difference.

Keetch has found a basis for classifying the rate of drying of dead fuels, which is a good unifying concept. He uses the term "timelag constant" in identifying forest fuels with similar drying characteristics. If we can clearly distinguish whether fuel dries out enough to burn in 2 hours, 2 days, 2 weeks, or 2 months, we can then clarify many of the things that cause confusion. It makes little difference whether a quick drying fuel consists of curled oak leaves in the East or ponderosa pine needles in the West; if the rate at which they dry out or take up moisture is the same, the conditions under which they ignite will also be similar.

It is quite probable we will end with a rating system that uses at least two indexes—one that shows the effect of today's weather, and one that shows the cumulative effects that increase or decrease the severity of burns. In addition, drought indexes that show periodic buildup of abnormal conditions will be needed in many areas.

The program was reviewed in August with a committee of field advisers. It was decided that the research needed to provide a complete numerical basis for a national system of danger ratings would delay the project immeasurably. Consequently, only the most important research on fuel moisture will be carried out at the new fire laboratory now available to us. For other relationships we shall depend primarily on bringing together the most reliable information we have as the base for a trial system to be ready for testing in 1961. The test will be started in regions where revision of existing ratings has been deferred, and in other places where there is special interest in helping to develop a national system. A 2-year period of testing is contemplated, with the objective of a complete system by 1963.

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Marking Controlled Lightning Fires

Often after a lightning storm some of the resulting fires that have been controlled but not extinguished will continue to smoke for days. Because all fires from a single storm do not occur simultaneously and yet may occur within a small area, confusion results for the aerial patrol and the dispatcher and crew boss in deciding whether the smoke they see is from a controlled fire or a new one.

We now mark controlled fires with strips of orange crepe paper about 6 inches wide and 7½ feet long. The crew boss places the paper in the form of an X across brush or on the ground close to the fire's perimeter. If possible, it is placed so that it will be visible from the air. Crepe paper is preferred to cloth because it will weather and fade within 2 or 3 weeks after it is used. The fading prevents possible confusion between old fires and fires that follow new storms. Then, too, the paper is cheaper than cloth.—WILLARD J. VOGEL, *Forester, Yakima Indian Agency, Bureau of Indian Affairs.*

OBJECTIVES IN FIRE CONTROL PLANNING

LLOYD R. OLSON
Forester, Division of Fire Control, Washington Office,
U. S. Forest Service

Objectives are the basis for standards of performance for fire control. From them must be set up comparable standards of protection between planning units for each timber resource, forest type, value class, hazard, and risk. Fire control based on well-developed plans and uniformly applied objectives thus provides a case for adequate financing in each protection unit. Equally important, a sound approach is provided for presenting the needs of fire control to budget authorities.

Some changes in fire control objectives have occurred through the years. One reason is the tremendous increase in forest values; another is that refinements in the technique of setting objectives have helped clarify the fire control problem.

A long-term objective of fire control is to hold losses from fire to a level determined by resource managers to be tolerable for each resource and yet permit successful management. This is accomplished by limiting the size of individual fires and the average annual total burned area to the maximum that can be tolerated for each resource in the management unit. Expressed in another way, the total cost of fire control plus the total loss from fires that do occur will be the lowest possible for each resource requiring protection.

Values are a major control in setting objectives. Where no values exist, there is no loss when fires burn. The higher the values, the greater are the justifiable costs of protection. Many values in the forest can be destroyed by fire. Some, such as timber, forage, and improvements can be appraised on a dollar and cents basis. There is no such measure for many other forms of use such as recreation; and soil and water mean life itself. A price tag on these values could not be supported, and the value concept as justification for the planned fire control program could be seriously questioned. Where value classes are established there may be a question as to whether, for example, a class 5 value for timber is comparable to class 5 for soil and water, or for recreation resources. They may or may not be the same, but the method does provide a measure for comparing the protection job needed between planning units.

On the national forests, values are steadily increasing as the uses of the forests increase and population growth requires more forest products. These increasing values justify proportionately increasing expenditures for fire control. What would have been an allowable loss for a forest resource 40 or even 20 years ago would not be now. And 20 years hence objectives may need to be much higher than they are now. There may be some areas where the objective should be complete exclusion of fire.

The national fire planning objective of the U. S. Forest Service for the next 5 years is to hold average annual burned area to one hundredth of one percent for value class 6, i.e., the highest value class used in national fire planning, and to 32 hundredths of one percent for the average of the lowest values. Some extremely valuable areas will require higher protection standards; other substantial areas can be burned annually without seriously impairing forest values. Some forest values may not be realized because of the excessive cost of fire control and potential damage to higher value resources in the area. Examples would be closure to recreation use during critical fire weather in some of the highly flammable watersheds in southern California, or in areas of unburned slash in the Pacific Northwest.

The maximum size individual fire that can be tolerated will be quite small on many areas. National objectives are to control all fires on lands in value class 6 at 10 acres or less. Other areas where the maximum size fire objective is significant would include recreation areas, municipal watersheds, higher erodible soils, and areas where timber reproduction becomes a problem following fire. On many areas the size of individual fires may be relatively unimportant so long as the average annual allowable burn is not exceeded. Regional resource and fire control managers will determine maximum size fire objectives for lands in value classes below class 6 within each fire protection unit and based on local conditions and resource requirements.

National fire planning instructions provide for control of maximum allowable annual burn by use of many fire control techniques. However, primary control is achieved on the basis of percentage of hour control coverage by value classes. Coverage ranges from 95 percent or more for the highest value class (class 6) to 40 percent or less for the lowest value class. If analysis on a planning unit shows too much loss is occurring in any value class, planners should consider increasing (a) fire prevention effort, (b) the percentage of area covered within hour control time limits, and (c) strength of initial attack.

Where maximum size fire objectives are critical, particular attention will be needed to provide for adequate, readily available, and properly equipped reinforcements for the initial attack crews. Hazard reduction, firebreaks, and other advance preparation to stop spread of fires may be needed to attain objectives.

Fire planning should provide for the manpower, equipment, and facilities to attain fire control objectives during average worst fire weather. It must also provide for expansion to meet the absolute worst should it occur. Needless expense must be avoided during favorable fire weather. Fire planning is not concerned with fire control financing currently available, but rather in devising the most economical fire control system that will meet objectives. A well-prepared plan can be adjusted to make the best use of financing that is provided. Likewise a well-developed plan is indispensable to those who must determine the amount of financing that should be provided for fire control.

SMOKEY BEAR SIGN MOUNTING

EMIL J. KULHANEK
St. Regis District Ranger, Coeur d'Alene National Forest

An easily constructed mounting for the large Scotchlite Smokey Bear sign was designed by Russel Mainwaring, Foreman, for use on the St. Regis District (fig. 1). The chief advantage of this design is the ease in which the sign can be put up and taken down. The sign is hung by two strap iron hangers and anchored with two 3/8-inch carriage bolts.

Material list:	*Number*
Lumber:	
2 by 4 by 75 inches	2
2 by 4 by 60 inches	1
2 by 4 by 48 inches	3
Posts, 8-inch diameter by 11 feet	2
Iron straps, ¼ by 1 by 12 inches	2
Carriage bolts:	
¼ by 2½ inches	6
⅜ by 4½ inches	2
Lag bolts, ⅜ by 4 inches	4

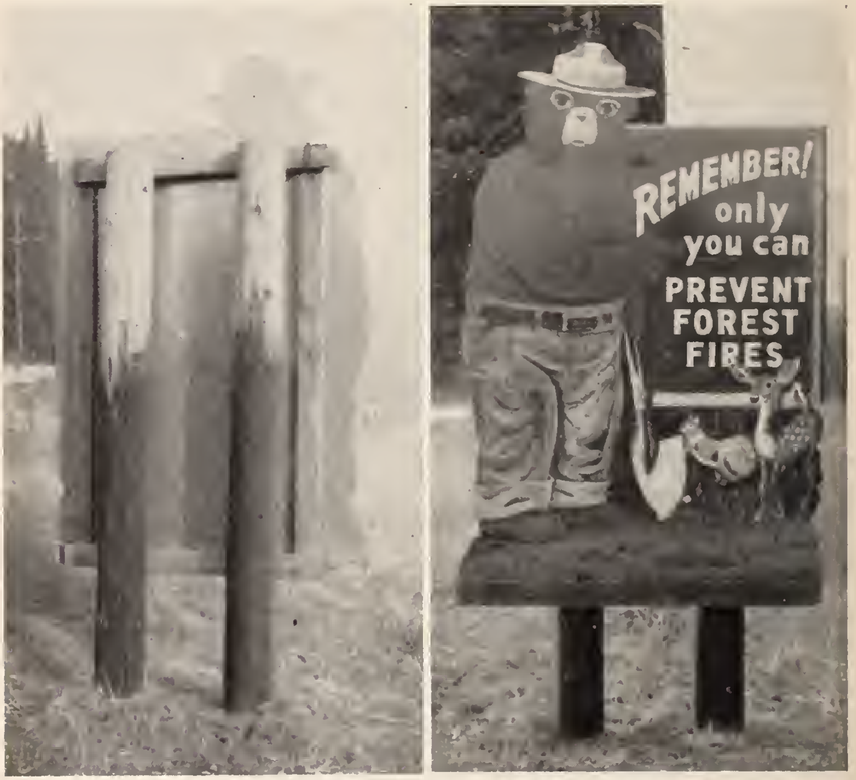

FIGURE 1.—Smokey Bear sign in place.

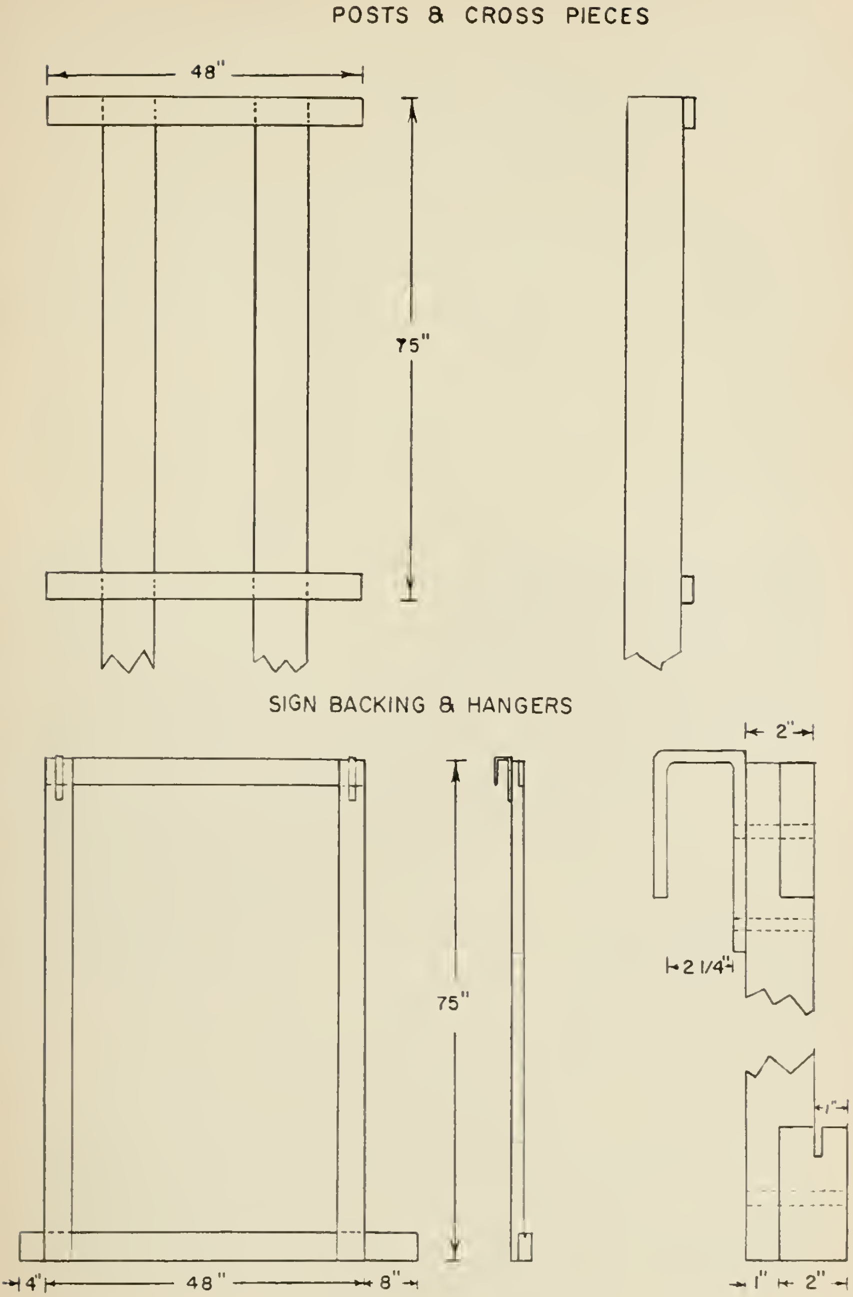

Figure 2.—Construction details.

Construction details.—Saw longitudinal groove in the 2- by 4- by 60-inch piece slightly wider than the thickness of the sign. Construct sign backing using lap joint construction. The bottom piece should extrude approximately 1 inch so that the back of the groove is flush with the rest of the sign backing (fig. 2). The joints can be fastened with either nails or screws but centers should be clear for boring bolt holes. Place sign face down on sawhorses and position backing on sign. Drill the two upper corner holes and bolt. Drill the side holes and bolt, being careful in positioning the holes not to go through the lettering on the face of the sign. Form the hanging brackets from ¼- by 1- by 12-inch strap iron and bolt to the sign. The corner hole may be used for the upper hole for fastening the bracket. Touch up the bolt heads with paint to match the sign.

The posts and crosspieces should be assembled at the sign site. The 11-foot post allows for approximately 3 feet in the ground and 2 feet clearance between the sign and the ground. Actual length of the posts will have to be determined by the location. The posts should be set approximately 2 feet apart. The crosspieces are leveled and bolted to the posts with the 4-inch lag bolts. Hang the sign, then drill through the bottom of the hanger and lower crosspiece. The sign is then bolted with two ⅜- by 4½-inch carriage bolts.

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Radio-Equipped Fire Tractors

In the spring of 1959, we acquired a surplus mobile radio and mounted it on one of our fire tractors. Mounting space for this old-type radio was a problem because its transmitter and receiver were in separate containers. We finally bolted it to the running board and held it in place with steel straps that were placed on the inside to prevent snagging. It was also necessary to adjust the tractor's voltage regulator to provide more generator output, since sets of this vintage cause a high battery drain.

To override the tractor's noise, a transistor-type speaker is used. Transmissions over this type of speaker are clearly understood a quarter mile away, and reception by the tractor operator is equally good. He usually works with the set at half volume.

Although no rubber padding or spring mounts were used, we have not had trouble with vibration loosening tubes or snapping soldered connections. Even though the set is not sealed against dust, no malfunctions have occurred and only an occasional cleaning with an airhose has been necessary.

The radio-equipped tractor has enabled us to attain better coordination in our fire control efforts, because the fire boss and the tractor operator are in direct communication. A guide to accompany the tractor and foot messengers are rarely needed. This practically eliminates delays and misunderstandings. Impending dangerous conditions and any change in plans are known by the tractor operator almost as soon as they are known to the fire boss or scout, and the tractor operator in turn is able to keep the fire boss fully informed of progress being made, breakdowns, and supply needs.

When we replace the present set, a dashboard-mount type will probably be attached to the side of the seat. However, the size of most sets available today is such that it should present no mounting problems.—WILLARD J. VOGEL, *Forester, Yakima Indian Agency, Bureau of Indian Affairs.*

THERMISTERS FOR MEASURING TEMPERATURE OF FOREST FUELS

Bob Steele
School of Forestry, Montana State University

The glass probe thermister may be successfully used to measure the surface temperature of forest fuels that are exposed to direct sunlight or that are exposed in partial shade. Such temperature measurements are of value in determining the flammability of twigs, limbs, and chunks, especially in logging slash.

The surface temperature of these pieces of fuel could not be measured with an ordinary bulb type thermometer because too great a percentage of the thermometer bulb is exposed to the air and too little of it actually touches the wood surfaces that are being sampled. A device was needed to measure temperatures at a tiny spot along the surface of the fuel and still not be measur-

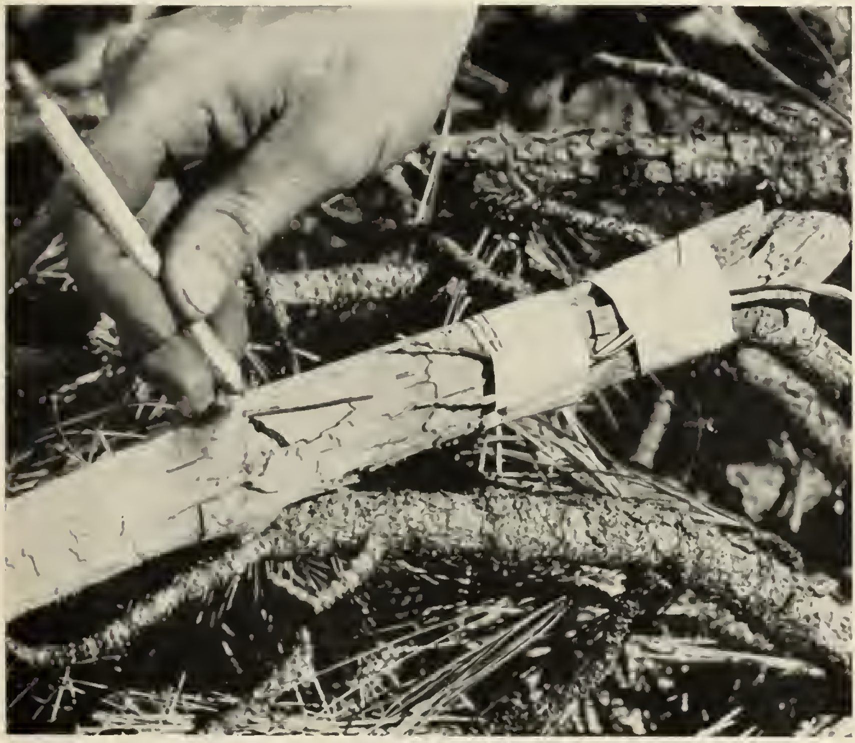

Figure 1.—Thermister in place; wires at right lead to ohmmeter. Pencil points to sensitive tip.

ing air temperatures that exist above and around the individual fuel pieces. This device also had to be independent of solar radiation falling on it.

The glass probe thermister consists of a glass rod 0.07 inch in diameter, 2½ inches long, terminating in a glass bead tip 0.10 inch in diameter. This bead tip contains a mixture of oxides of manganese, nickel, cobalt, and copper molded into a ceramiclike substance and encased at the end of the probe. This tip serves as an electrical resistance unit which changes its resistance with changes in temperature. The material in the tip has a high negative temperature coefficient, which means that the higher the temperature, the lower the resistance. Through the length of the thermister are fine wires molded in the glass to which are attached the leads of an ohmmeter (fig. 1). This meter gives a direct reading of electrical resistance in the circuit.

To measure the temperature of a forest fuel, the sensitive tip is placed against the surface of the material and the whole thermister secured in place (fig. 1). As resistance changes with temperature, a corresponding current change can be noted on the

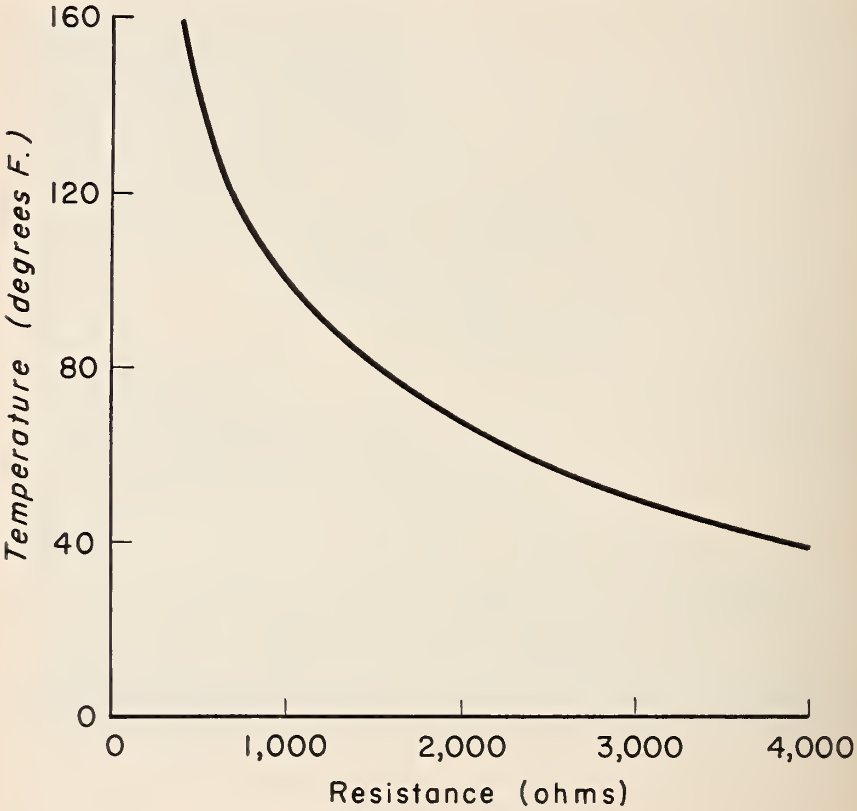

FIGURE 2.—Typical conversion curve for resistance to temperature.

meter and the temperature calculated by reading the meter, which is calibrated in ohms of resistance.

The manufacturer of the thermisters provides a chart showing a curve of the relationship between temperature and electrical resistance for the particular type of thermister involved (fig. 2). Resistance readings taken with the ohmmeter can readily be converted to temperature by use of these curves.

Glass probe thermisters may be purchased commercially from electronics distributors for about $2 each. They come in a choice of temperature ranges from –70 to 500 degrees F. The ones used here cover a temperature range of 60 to 140 degrees F. These little thermisters are extremely stable, shock resistant, and have unlimited life. They are compact and easy to use.

Over the course of the summer, temperature measurements were made with thermisters on the surface of limbs, twigs, and chunks of ponderosa pine exposed to full sunlight. The surface temperature of these fuel components reached 120 degrees when

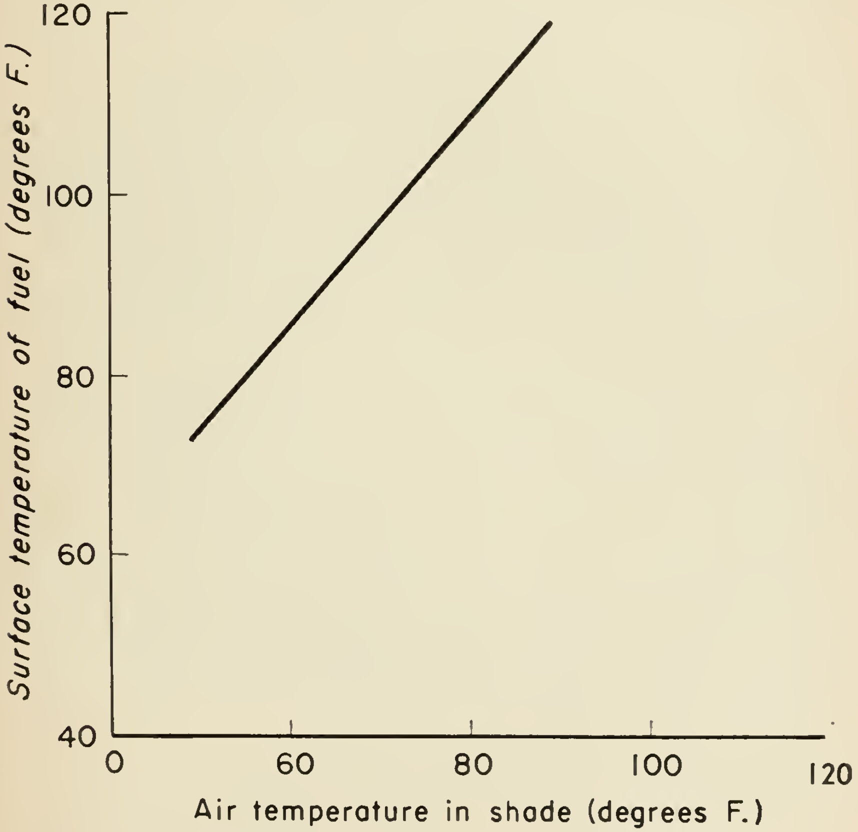

FIGURE 3.—Relationship between air temperature in the shade and the surface temperature of fuels exposed to the sun.

the air temperature in the shade of a standard weather instrument shelter reached 90 degrees; for an air temperature of 70 degrees, fuel temperatures reached 98 (fig. 3).

The temperature comparisons made between twigs of ½-inch diameter and branches about 1½ inches in diameter showed no significant difference in surface heating. The difference between air temperature in the shade and the surface temperature of the exposed fuel, however, was very significant. This difference was greatest during midafternoon and amounted to 30 degrees as a maximum. The fuels evidently absorbed enough heat during the sunshine period of the day so that afternoon readings were a little higher than those made in the morning and at noon.

The thermister is capable of following rapid changes in fuel temperature, and differences up to 5 degrees can be noted between cloudy conditions and clear sky conditions. The measurements reported here, however, were confined to periods of full sunlight.

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Colored Smoke Aids in Fire Location

During the past two fire seasons our fire crews have used smoke flares to increase efficiency in finding hard-to-locate fires. Of the flares used, the Kilgore has proved most practical as to size, ease of carrying, and smoke volume. It is 1½ inches in diameter and 6 inches long, and it weighs 4½ ounces. One end emits a bright fluorescent, orange smoke for approximately 45 seconds, and is for daytime use; the other end emits red smoke for nighttime use. This flare releases no sparks or other residue while burning, and with reasonable care is safe to use in very dry areas. We found that orange smoke rather than white or gray is easier to see against any background. A noncolored smoke is especially confusing when there are several fires in the same area.

When the fire crew has difficulty in locating a fire, it radios the nearest lookout or aerial observer of its location and intention of using a flare. The lookout or observer upon seeing the orange smoke advises the fire crew where it is in relation to the fire. If guidance is to come from the lookout, it is necessary for the smoke to rise above the trees to be seen. Thus, a crew member may have to climb a tree and release the smoke. Release of smoke from the ground is usually satisfactory for aerial detection. When a strong wind is blowing, or a large volume of smoke is needed because of a heavy timber cover, two or more flares are used at the same time.

Notification by radio is always made before release of the smoke for fire guidance. If smoke is used without notification, it is a signal for immediate help. The need for this arrangement became apparent several years ago when a fire jumped control lines and destroyed the mopup crew's radio. The crew had to drive 15 miles over bad roads for help, and much time and acreage was lost.—WILLARD J. VOGEL, *Forester, Yakima Indian Agency, Bureau of Indian Affairs.*

WILL BORATE KILL SOUTHERN TIMBER?

G. R. FAHNESTOCK and R. W. JOHANSEN
Southern and Southeastern Forest Experiment Stations

Use of the fire retardant sodium calcium borate to construct fireline has increased greatly in the West since 1956 and has aroused considerable interest in the Eastern United States.

One characteristic of borate, its toxicity to vegetation, has received little publicity, although it is mentioned in one of the earliest articles on borate as a fire retardant.[1] Since the danger of tree kill and soil sterility accompanies the use of this material, tests were established in Louisiana and Georgia to determine the extent of damage when borate is ground-sprayed for fireline construction and when it is dropped from aerial tankers.

LOUISIANA TESTS

The Louisiana tests were carried out by the Division of Forest Fire Research, Southern Forest Experiment Station, in cooperation with the Kisatchie National Forest, Louisiana Forestry Commission, and U. S. Borax and Chemical Company. Slurry containing approximately 4 pounds of sodium calcium borate per gallon of water was prepared with an injector-type mixer. A helical impeller pump, developing about 200 p.s.i. pressure, supplied water for the mixing operation and delivered slurry from storage to the fireline. The retardant was applied through 60 feet of 1¼-inch rubber hose equipped with a 6-foot pipe applicator and a U. S. Navy fog tip delivering 10 to 14 gallons per minute. All spraying was done early in December 1957.

Some lines were sprayed primarily for demonstration of fire retardant action; these also have furnished an opportunity to observe general effects of the chemical on vegetation. Additional spraying of strips and individual young trees provided more detailed checks on toxicity. Demonstration firelines received 5 to 7.5 gallons of slurry per 100 square feet of ground surface. Since these rates of application appeared to be near or below the minimum for effective fireline in heavy rough, and because a rather rigorous test of toxicity was desired, three toxicity-test strips in a heavy grass rough were given 10, 12.5, and 15 gallons per 100 square feet (fig. 1). An effort was made to cover completely all exposed surfaces of dead fuel and living vegetation.

In addition to the test strips, six trees each of planted slash, longleaf, and loblolly pine 6 to 10 feet high were crown-sprayed. On three trees of each species the entire crowns were sprayed with about 2 gallons of slurry; on the other three trees, only half of each crown was sprayed, with about 1 gallon of slurry.

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[1] Miller, Harry R. Sodium calcium borate as a fire retardant. Fire Control Notes 17(4): 25-28. 1956.

The toxicity-test strips and the intervening untreated area were planted with 1-0 loblolly pine in January 1958. By October, 95 percent of the planted seedlings on treated strips were dead, as compared with 5 percent on untreated strips. However, 88 percent of those on untreated strips showed symptoms of boron injury because heavy rains had spread the chemical from sprayed strips. Mortality on sprayed strips did not vary with rate of application.

Slash pine seed sown in March 1958 on sprayed strips did not germinate. On unsprayed strips, borate washed in by surface

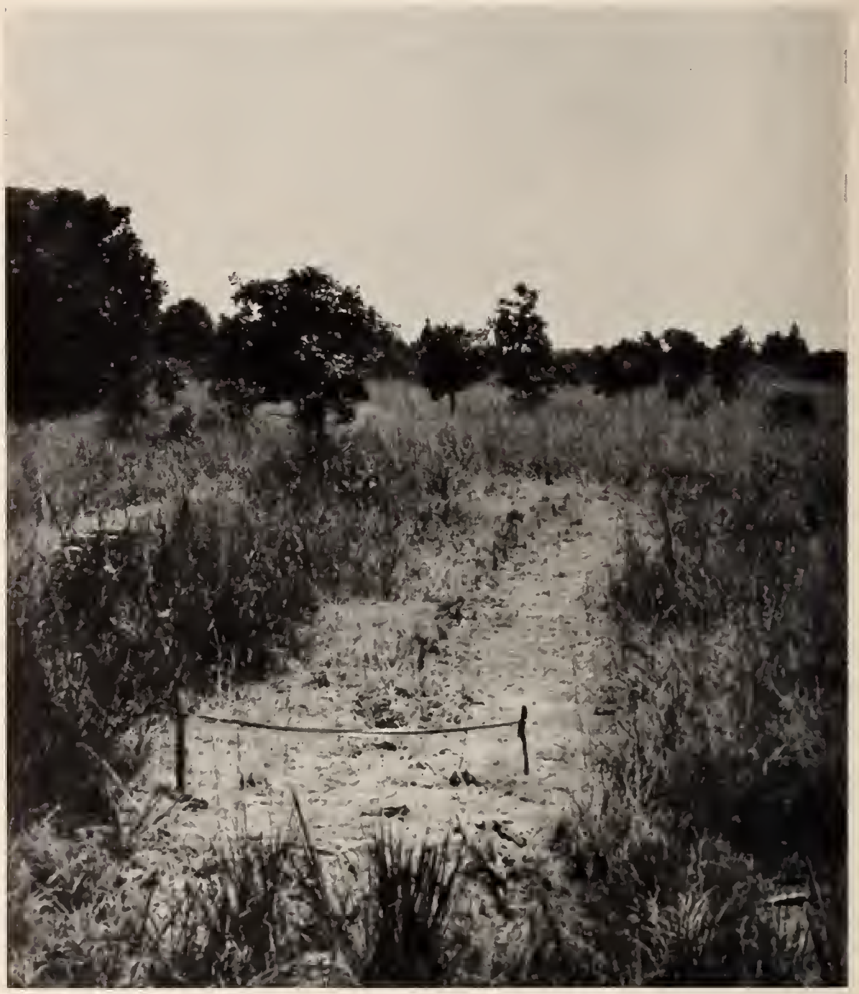

FIGURE 1.—August 1958, condition of strip sprayed the previous December with 12.5 gallons of borate slurry per 100 square feet. Appearance of area was the same in October 1959.

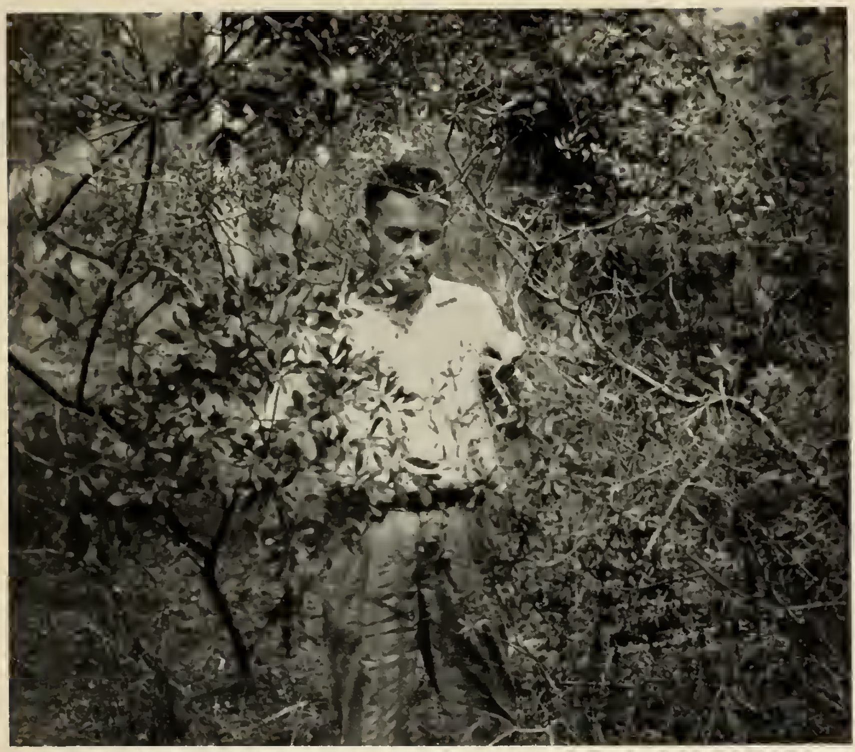

FIGURE 2.—Contrast between wax myrtle growing on 7-month-old borate fireline (right) and branch from a normal plant.

water prevented germination on half the seed spots and caused early seedling mortality on others.

The area was replanted in January 1959, again with 1-0 loblolly. By late October, 97 percent of the trees planted in 1958 and 1959 on treated strips were dead. Again mortality was independent of rate of borate application. Only 9 percent of the 1959 seedlings had died on two check strips completely unaffected by borate, but 44 percent were dead on the check strip to which borate was carried by surface water. The three 1958 check strips had had 86, 46, and 16 percent mortality, depending on the degree of side effect from adjacent treated ground.

A heavy rain 2 days after spraying washed all visible borate off the crown-sprayed pines. The trees made normal height growth in 1958 but lost an abnormal amount of old foliage. By August the 1957 needles that had not yet fallen were dead for about half their length, and tips of 1958 needles showed injury. By mid-September dead length of new needles averaged about 2 inches on loblolly and longleaf pines and about half the total needle length on slash. All sprayed slash pines had poor color and one died, though not necessarily from boron injury.

In April 1959, the same symptoms of injury persisted, most acutely on slash pine. By October, differences between treated and untreated loblolly and longleaf pines were discernible only on close inspection, and sprayed slash pines looked more nearly normal than previously. However, 1959 height growth averaged 19 percent less on 18 trees that had been treated than on their paired, untreated controls. The reduction in growth was greatest for slash pine and least for loblolly, but the small number of trees involved precludes valid generalization. At no time was any appreciable difference noted between fully sprayed and half-sprayed trees.

Borate killed or severely injured most brushy and herbaceous vegetation on both toxicity-test strips and demonstration firelines (fig. 2). A few species, notably hawthorn, appeared resistant. Some trees on demonstration firelines were slightly injured. Early 1958 leaves of sapling sweetgum were burned at the edges, but recovery appeared complete by fall. Several longleaf and loblolly pines of small sawtimber size lost abnormal amounts of foliage; their crowns still appeared thin in October 1959. Injury to vegetation on firelines that received 7.5 gallons per 100 square feet at first appeared comparable to that on toxicity-test strips treated with 1⅓ to 2 times as much, but the 7.5-gallon treatment permitted considerable reestablishment of grass in 1959.

In January 1959, the Kisatchie National Forest planted 1-0 slash pines on a sizable area that included the 1957 demonstration firelines. By late October, 13 seedlings had died out of a row of 100 on a borate fireline, and 50 were in poor vigor. On untreated ground nearby, no seedlings had died and only 1 out of 100 had poor vigor. New leaders were either weak or absent on most young trees on the fireline, and average total height was 12.3 inches. Most trees on untreated ground had vigorous 1959 leaders; total height averaged 18.1 inches.

GEORGIA TESTS

At the Southern Forest Fire Laboratory in Macon, Ga., the effect of borate was measured at application rates of 3 and 6 gallons per 100 square feet, comparable to the effective concentration zones made when the material is delivered by a TBM (air) tanker.

The effect of borate on the germination of loblolly pine and sweetgum seed was investigated at the Georgia Forestry Commission's Seed Testing Laboratory. The seeds, 200 per dish, were handled in the same manner as in all other germination tests conducted at the laboratory except that borate was added to some of the dishes at the rate of 3 and 6 gallons per 100 square feet. The test was begun on October 28, 1958, and terminated 1 month later. None of the treated seeds germinated, as compared with 84 percent of the untreated pine and 18 percent of the untreated sweetgum seeds.

In September 1958, borate was applied at the same rates to the 1-month-old potted loblolly pine and sweetgum seedlings. In one phase of the test the chemical was applied to the soil; in the other, only to the above-ground parts of the young trees, with the soil shielded. The soil application was more detrimental to both species than the aerial application.

Species and treatment[1]	*Amount of slurry per 100 sq. ft.* (*gallons*)	*Seedling mortality* (*percent*)
Sweetgum:		
Ground	3	74
Ground	6	80
Aerial	3	0
Aerial	6	13
Check	0	8
Pine:		
Ground	3	47
Ground	6	60
Aerial	3	0
Aerial	6	0
Check	0	2

[1] 60 seedlings in check treatments, 15 in all others.

An attempt was also made to determine the effect of borate slurry on natural 2- to 3-foot loblolly pine and sweetgum seedlings. In August 1958, fifteen 5-tree pine plots with trees closely spaced were established. Five treatments were replicated thrice:

1. Borate sprayed on foliage at 3 gallons per 100 square feet.
2. Borate sprayed on foliage at a 6-gallon rate.
3. Borate sprayed on the ground at a 3-gallon rate.
4. Borate sprayed on the ground at a 6-gallon rate.
5. Check plot—no treatment.

None of the pines died within 9 months following treatment, but there was evidence of some slurry effect, the greater from the aerial application. The extent of injury ranged from minor needle kill to slight growth retardation on most treated trees, with complete growth inhibition in several of the aerially treated trees.

The sweetgum seedlings were not closely spaced in the forest, as were the pines. Thus plots could be made up of only one or two trees. The treatments were identical to those imposed on the pine plots but were replicated 4 times.

Borate had considerably more effect on sweetgum than on pines, although none of the gums were completely killed. Again aerial application caused the greater damage; almost all of the trees suffered some stem kill or partial defoliation. Growth was somewhat reduced by the ground application.

The contradiction between the effect of ground and aerial applications on wildling and potted seedlings probably can be explained best by the limited area of ground application around the wildlings. An area 3 by 3 feet with the wildling stems in the center was subjected to spray. Since the root system of a 2- to 3-foot seedling undoubtedly occupies considerably more area, it is probable that only part of the roots were exposed to the borate. In the pots, by contrast, all roots were confined within the application area. This reasoning is supported by the fact that an aerial drop of borate slurry on a small sawtimber stand of longleaf pine caused considerable mortality in all size classes, not to mention kill-back of palmetto and gallberry (fig. 3). Other studies have established that the maximum concentration reaching the ground from such a drop is 3.5 gallons per 100 square feet.

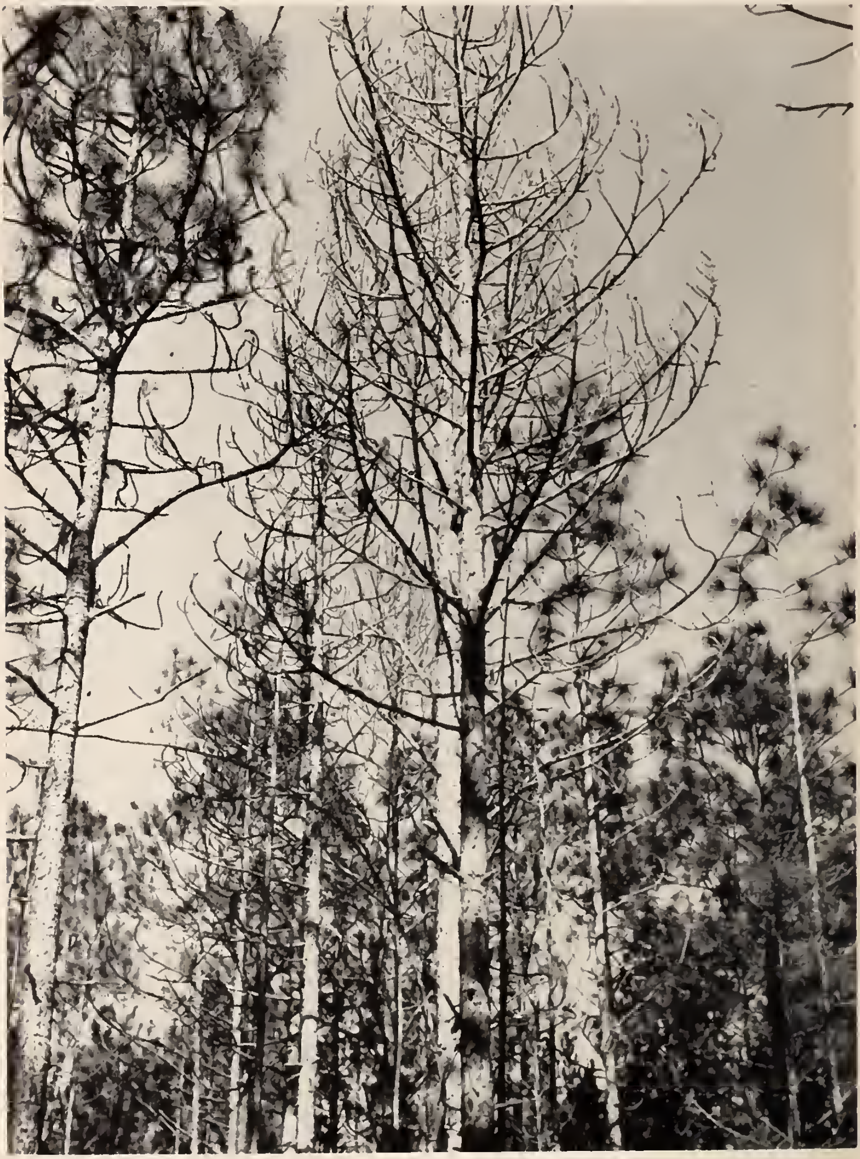

FIGURE 3.—Timber killed by 220-gallon borate aerial drop. (Photograph by Georgia Forestry Commission.)

CONCLUSIONS

In the tests in Louisiana the heavy applications of borate required for fireline construction rendered soil unfit for pine planting or direct seeding for at least 2 years. Heavy rains washed some borate to untreated areas, thus extending the toxic area. Height growth of crown-sprayed pines was still subnormal the second year after treatment.

Tests in Georgia with lower application rates of borate demonstrated the damaging effects of the slurry to all plant parts at applications as low as 3 gallons per 100 square feet. When a large area is covered at this rate, tree mortality can be expected, even in sawtimber stands.

Forage for livestock and wildlife is killed or inhibited, but the fire retardant itself is nontoxic to animals. If only emergency use is made of borate for fire suppression, the area of soil sterilization or vegetation injury will be small, probably insignificant. On the other hand, widespread use of borate could result in more than acceptable damage, especially if the toxicity is found to persist for several years, or if local conditions permit surface water to spread the chemical.

MOBILE LOOKOUT

H. K. Harris
Forester, Missoula Equipment Development Center,
U. S. Forest Service

The mobile lookout shown in figure 1 was designed for easy installation on any observation point on a road or truck trail. It is intended for use where continuous or nearly continuous observation is required for temporary hazards, such as logging operations, slash or blowdown areas, or where other special observation is needed. The trailer may also be used by work crews or for other supplemental housing.

A complete home on wheels is provided. The dining and living area is arranged to convert quickly into a spare bedroom. Table and cushions can be made into a bed faster and easier than the davenport used for this purpose in many commercial units. A gas heater is located at the right near the stair ladder that leads to the cupola. The kitchen area is equipped with a conveniently located gas range, refrigerator, and sink, and a back bedroom has bunk beds to the right and left of a center aisle.

This home on wheels also has toilet and shower facilities, a gas water heater, and a good-sized wardrobe-type storage closet. They are located near the center of the trailer to provide proper weight distribution and structural strength. Although the furnishings and interior of the living quarters are not as elaborate as many in commercial trailers, they are adequate.

The design of the cupola is of special interest. This part of the trailer has hinged walls that fold compactly into a hatch on the roof. When the walls are folded, the ventilated cupola roof becomes the hatch cover. Metal-sash windows in the cupola can be opened, and they can also be quickly and easily removed to reduce the weight of the walls when the cupola is being folded or raised. Attachments are provided at the corners of the cupola roof for light guy wires, to steady the trailer at windy locations. The roof of the trailer is a flat-deck type for ease in raising or lowering the cupola.

Trailer weight is well distributed on the wheels, and dual wheels and a heavy frame give reserve strength on rough roads. The 23-foot trailer body is a compromise between adequate living space and best maneuverability.

Operational tests and a season's use indicate that the design of the mobile lookout is practical. Some modifications and improvements are planned in future designs as a result of these tests and group evaluation. The most important of these are as follows:

1. Provide a simple mechanical hoist to raise the cupola roof and hatch cover. This will make it easier for one man to assemble or fold the cupola.

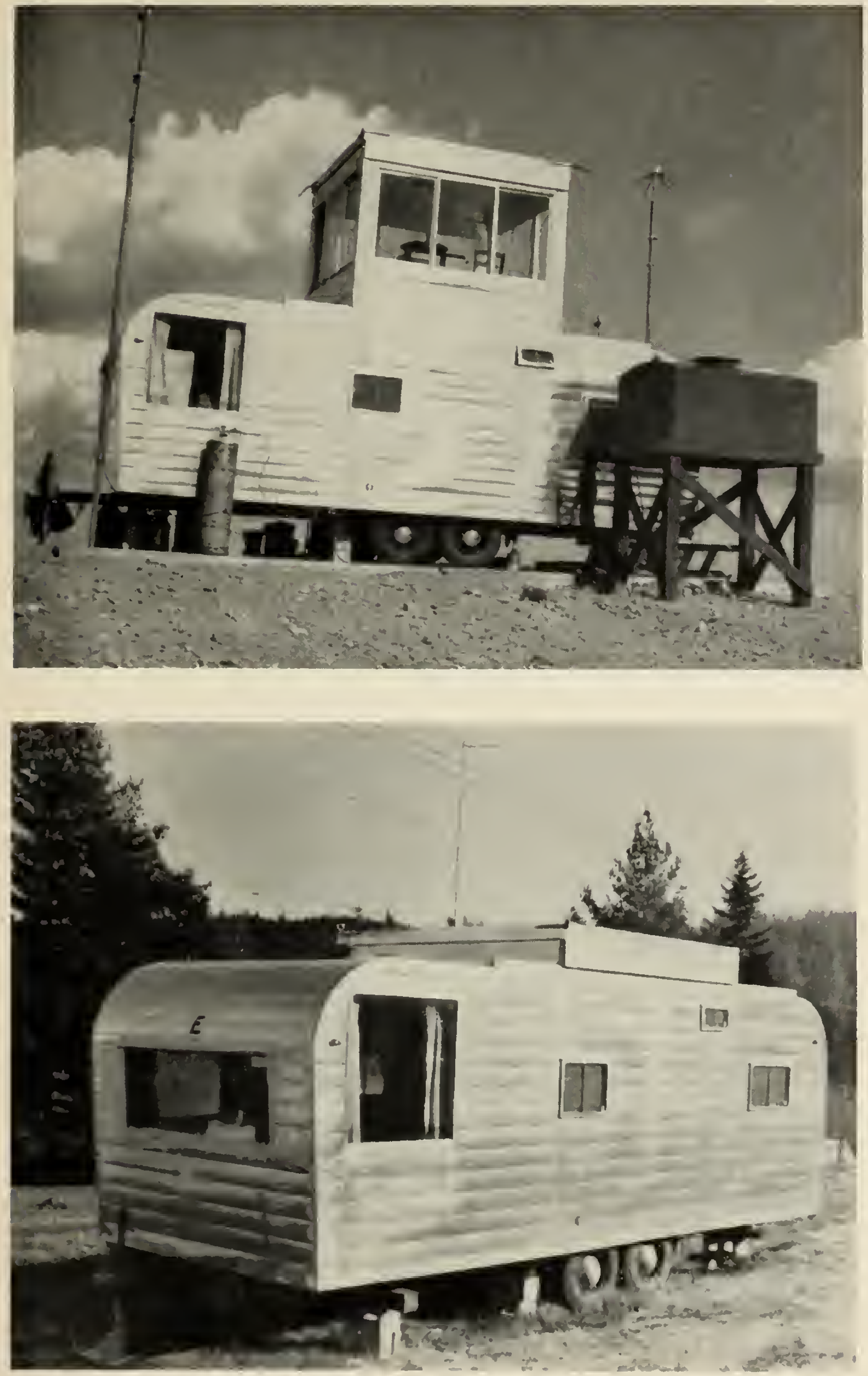

FIGURE 1.—Mobile lookout with cupola in raised and folded position.

2. Install colored plastic window visors or sunshades on all sides of the cupola to reduce glare.

3. Increase the height of the cupola windows about 4 inches for better visibility.

4. Paint the roof of the trailer with a dull paint to reduce sun glare.

5. Provide an aluminum water-storage tank for gravity water feed to shower and trailer plumbing. This will be designed as a part of the trailer roof but will require frame modifications. (Gravity-fed water from an outside tank obstructs visibility.) The storage tank will be filled only when the trailer is stationary.

6. Increase the size of the rear bedroom window to provide an emergency exit.

7. Increase the height of the front living room window for better visibility when the lookout is there rather than in the cupola.

8. Provide storage drawers under the bunk beds.

9. Include provisions for radio installation in the new trailer design.

10. Install corner guards and bumper protection for rear of trailer.

NEW FABRIC SLEEPING BAG

W. C. Wood
Equipment Specialist, Missoula Equipment Development Center, U. S. Forest Service

The kapok sleeping bag in common use has become obsolete. Its design is not compatible with present-day manufacturing techniques and better insulating materials are now available.

The Missoula Equipment Development Center has completed the development of a new fabric sleeping bag for forest firefighters.[1] It is 33 inches wide, 80 inches long with full-length, heavy-duty zipper and a 3-pound preshrunk, washable, snap-in, dacron-insulated liner (fig. 1). A preshrunk, washable, snap-in sheet is provided. The new bag has less bulk and weight and is warmer than the standard kapok. Ordinarily a 3-pound bag is adequate for summer; a 2-pound supplemental liner may be snapped in for additional warmth.

In colder weather the user can adjust to satisfactory sleeping temperatures by crawling between any of the combination of layers. In extreme cold a second supplemental liner can be substituted for the sheet. This design provides a wide range of temperature-weight adjustment capabilities, since the outer shell can be equipped with a single, 2-pound liner or a combination of

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[1] Adopted as Forest Service standard. USDA Forest Service Specification No. 5100-33. Stocked by General Services Administration.

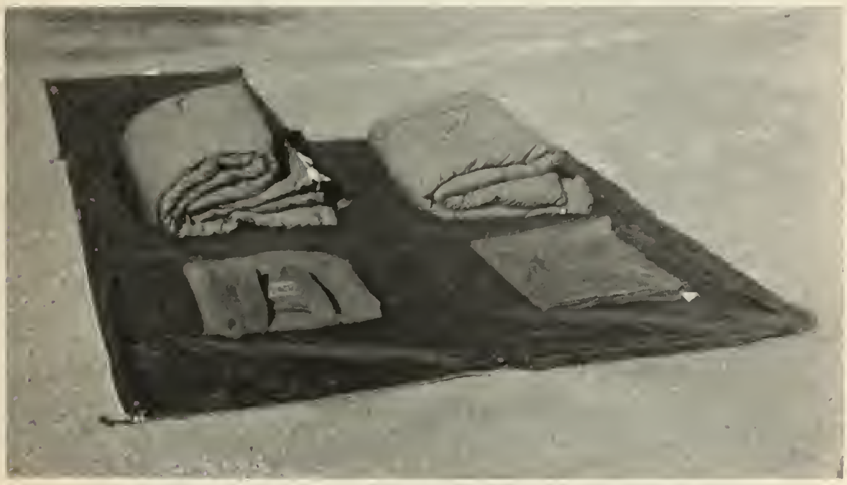

FIGURE 1.—Fabric sleeping bag components.

liners weighing 3, 4, 5, 6, or 7 pounds. The carrying bag with shoulder straps will accommodate extra clothing and personal gear when the 3-pound basic liner only is used (fig. 2).

An extensive investigation of sleeping bag use was made. Comfort and warmth requirements vary with individuals. Questionnaires were circulated to all Forest Service regions to obtain logistic information and field-use requirements. The comments received varied widely but it was obvious that a recreational, camper-type sleeping bag did not fully meet the requirements of forest firefighters. The majority favored a lightweight bag for use at minimum temperatures of about 32 degrees F.; the other 25 percent wanted a medium- or heavy-weight bag. Some wanted carrying straps, others a duffel bag or carrying case. About one-half wanted removable, washable sheets. The majority felt that an air-mattress pocket was not essential. The evaluation of field comments was based upon total use of sleeping bags in each area.

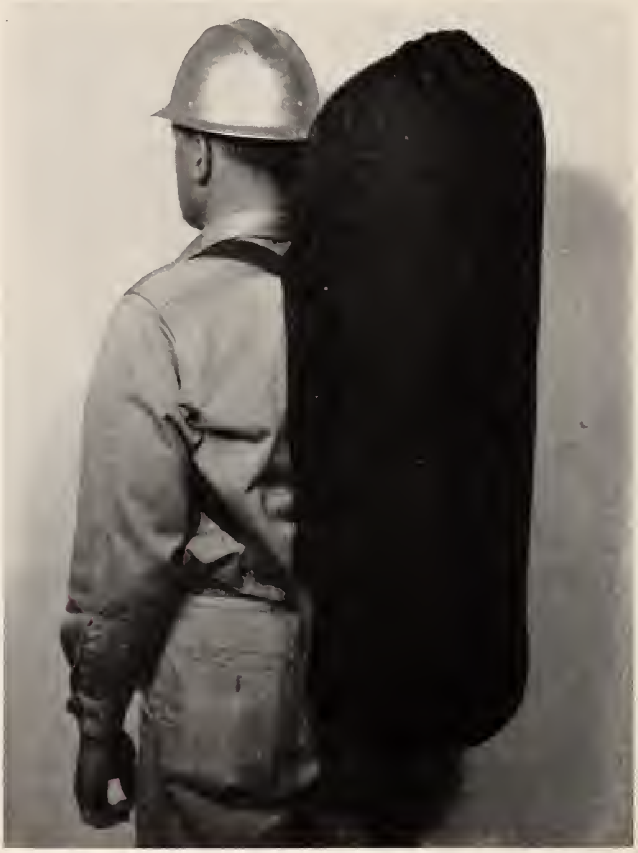

FIGURE 2.—Fabric sleeping bag in carrying bag.

The new bag is adaptable and will meet all the requirements established by the field. Certain features exceed field requirements; mainly because these added features could be obtained without penalty to cost or weight. For instance, an air-mattress pocket is automatically provided by the snap-in liner feature. An air mattress can be easily inserted between the basic liner and the outer shell. The carrying case with shoulder straps serves as a combination duffel bag and air-delivery protective container. A separable zipper allows two bags to be fastened together to form a double bed.

A bright yellow or orange top panel would impart higher visibility to expedite recovery from air delivery. This would also help locate and identify fire camps and bed grounds when viewed from the air. The use of a colored panel in the bag did not appreciably increase the cost in large-volume purchases but small unit purchases (of less than 2,000 bags) could not be made economically. For this reason materials were specified that are readily available and can be obtained by manufacturers in any quantity. To fulfill the high-visibility color requirement it is recommended that air-delivery sleeping bags be enclosed in bright yellow paper or plastic bags. Painting or dyeing a color stripe on the outer cover was found to be unsatisfactory.

PAPER (DISPOSABLE) SLEEPING BAGS

H. K. Harris
Forester, Missoula Equipment Development Center,
U. S. Forest Service

The paper sleeping bag was developed for use by forest firefighters where the cost of transportation, repair, cleaning, handling, and storage of the standard kapok bag was likely to exceed the initial cost of the paper bag (figs. 1 and 2). It is for one-trip use and therefore termed "disposable," and was not intended to equal a standard sleeping bag in either warmth or comfort. It was designed to provide a measure of protection against chill night winds and morning dew during midsummer when fires were most numerous and crew-sized fires most common. More than 300,000 have been purchased in the past 5 years.

Improvements in comfort, moisture resistance, and packing procedures would in all probability result in increased use. For example, one Forest Service region indicated that if the disposable sleeping bag were improved in warmth and comfort, it would be used on all crew fires as standard equipment. Most smokejumpers are now equipped with disposable bags for summer use. The season of use could be extended with only slight additional

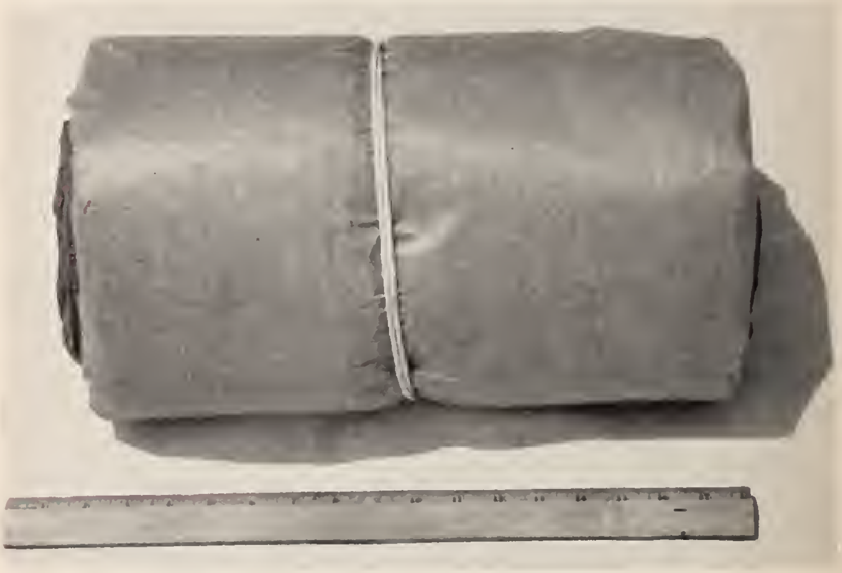

FIGURE 1.—Paper sleeping bag rolled and tied.

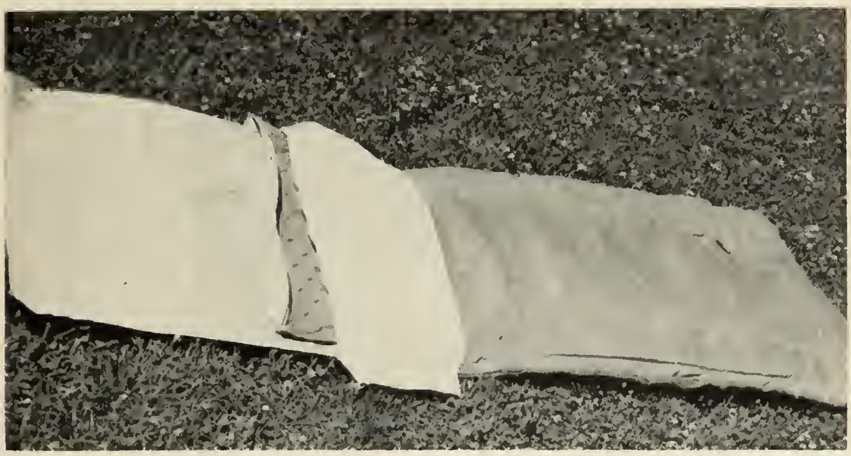

FIGURE 2.—Paper sleeping bag unrolled for use.

cost and weight. Improvements to the bag would develop other uses where the paper bag is not now considered adequate.

The improved bag would give any practical degree of warmth required for summer use. Newly developed paper products can provide a moisture barrier for the bottom of the bag. New seam designs will eliminate capillary action of present sewing. A disposable supplemental liner can be furnished for additional warmth only when needed and thus keep weight and cost to a minimum for most use. A plastic air mattress is available at nominal cost.

MONOAMMONIUM PHOSPHATE SHOWS PROMISE IN FIRE RETARDANT TRIALS

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Division of Forest Fire Research,
Southeastern Forest Experiment Station[1]

Monoammonium phosphate ($NH_4H_2PO_4$) solutions applied to flammable fuels in south Georgia have successfully stopped fast-moving head fires. The material appears to be an excellent fire retardant, and has other qualities that should favor its use in fire control. The salt readily goes into solution with water when the mixture has been recirculated through a centrifugal pump for approximately 10 minutes. A fertilizer containing 12 percent nitrogen and 61 percent P_2O_5, the material is not toxic to plant life. When compared with other retardants, monoammonium phosphate (MAP) is relatively light in weight, at 9.2 pounds per gallon (18-percent concentration). Later work may show even lower concentrations to be adequate.

After preliminary small plot trials showed that asbestos slurries, borate slurries, and MAP solutions were equally effective in retarding light surface fires, a full-scale field trial was made. The materials tested were borate, 4 pounds per gallon of water; powdered asbestos, 1¼ pounds per gallon of water; and MAP, 1⅔ pounds per gallon of water. All mixtures were dropped from Georgia's TBM aerial tanker at an altitude of 75 feet and 100 feet ahead of hot head fires. Results from water drops were used as a base for rating the different retardants.

The area used for testing the materials had been recently clear cut, leaving a 10-year rough of palmetto, gallberry, and grass, in addition to lopped pine tops. Fires burned extremely hot, so hot that a 220-gallon load of water merely slowed a test head fire which ultimately consumed all fuel. An equal quantity of retardant was used for each of the comparison drops. All these drops were replicated once to check response of the set head fires. Fuel moisture was 7.5 percent or less; wind speed varied between 6 and 12 miles per hour. MAP stopped the fires completely within a short distance of the outer edge of the drop zone along a line at least 175 feet long. Borate treatment did not stop the fires, although islands of unburned material were left in the drop zone. Results with asbestos were well below expectancy, in that fuels were completely consumed by the fires. Several hours after the drops had been made and the retardant material had dried on the vegetation, the unburned parts of the borate plots were reignited with a drip torch, whereas the MAP plots could not be reignited.

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[1] This article was presented as Southeast. Forest Expt. Sta. Res. Notes 137 in Nov. 1959.

One drawback of MAP is that it is somewhat corrosive to aluminum. This condition can be corrected by adding approximately 220 parts per million of sodium silicofluoride and 20 parts per million of ammonium molybdate to the solution. An area covered with MAP cannot be readily distinguished from the air, and this presents difficulties. Tests with coloring agents are now in progress.

PUBLIC INFORMATION CENTER ON LARGE FIRES

DON K. PORTER
Fire Prevention Officer, Angeles National Forest

Whenever a large forest or watershed fire occurs near a metropolitan area of over 6 million people a heavy demand for public information is placed on the agency concerned by press, radio, television, and general public for facts about the fire. Such a circumstance arose on October 13, 1959, when the "Woodwardia" fire started in the Angeles National Forest not more than 15 miles from the center of Los Angeles, Calif. Shortly after the initial attack forces arrived at the scene, requests were being received for information at the Forest Service dispatcher's office in Arcadia and the Los Angeles County fire dispatcher's office in Los Angeles. It was evident, after the first hour of the fire, that plans for serving the news media for "average" fires would not be adequate. In each dispatcher's office, the one press phone normally manned for this purpose was not able to take the load of requests for information.

The need for a fire information center was obvious and within 4 hours after the start of the fire such a center was established at the Los Angeles County Camp No. 2 in Oak Grove Park in northwest Pasadena. This area was approximately 100 yards from the Forest Service general headquarters directing the fire control efforts. Two information officers from other national forests were called, as well as one from the California Division of Forestry, to supplement the initial information men from the Angeles National Forest and Los Angeles County. This five-man information team was in full operation, on a 24-hour basis, by the second day of the fire.

The information center was established in a garage with three telephones, two tables, 8 chairs, radio monitors, and a blackboard. The blackboard was used for posting a map of the fire area showing the current boundaries of the fire and direction. This map was changed periodically as the fire advanced. The board was also used for listing current hot spots, special items such as homes, resorts, and cabins threatened, weather forecast, names of agencies working on the fireline, names of the fire boss and other overhead, number of men on fireline, number of fire trucks, air tankers, helicopters, and bulldozers. From the second through the seventh day, October 20, when control was attained, ten to twenty reporters and photographers could be found around the information center night and day. The information and map on the blackboard provided ready facts for any press representative just arriving, and all reporters had access to the same information.

This was by no means the largest fire to occur in southern California or in the region (14,045 acres of valuable watershed burned). However, due to the close proximity of the metropolitan area of Los Angeles, with flames that were visible from the downtown area, as well as all over the county, together with the smoke covering Los Angeles, a heavy demand for information about the fire was created. In the 7-day period of the fire, the information team answered an estimated 2,500 telephone requests, gave approximately 250 radio tape recordings, both by telephone and directly at the scene, arranged for TV and newsreel interviews, directed photographers to areas of the fire where the most dramatic shots could be taken *without interfering with the suppression forces.*

As the fire increased in size it was necessary to put one or two men of the information team on the fireline to get current and accurate information on the boundary of the fire, trouble spots, and dangers to inhabited areas. These reports were 'phoned into the center as "on the spot" information and then disseminated by the other members of the team to waiting reporters and in answer to 'phone requests.

Requests for news came from the four large daily newspapers of the Los Angeles area, twenty local daily papers, ten weekly papers, twenty radio stations, seven television stations, two national and international wire services, one local wire service, four network coast-to-coast TV and radio stations, one newsreel company, and three national magazines. Radio tapes were requested by 'phone from several eastern and midwest radio stations.

The information team also provided such service as information to property owners and cabin owners who lived or had cabins in the vicinity of the fire and to utility companies who had telephone or power lines in the area. In addition, services were provided to the 2,200 men on the fireline. The "Fireline News" was published by the information section on Sunday, October 18. This 1-page mimeographed sheet carried a sketch of the fire area, the number of men, air tankers, and fire equipment, and safety messages and words of encouragement from the fire boss, Forest Supervisor, County Fire Chief, and Deputy State Forester. General news such as football scores from Saturday's games were also included. The "Fireline News" was distributed to all seven fire camps and was flown by helicopter with food supplies to a spike camp. The paper proved to be quite a morale booster.

At midpoint in the battle of the "Woodwardia" fire another fire broke out on the Saugus District of the Angeles National Forest. This fire burned some 3,500 acres of watershed land 35 miles northwest of Los Angeles. Two men from the information team were dispatched to this area and telephoned their reports to the main center where information on this fire also was given to the press and to the public.

The main purpose of an information section in any large fire organization is to relieve the fire boss and line personnel of information responsibilities and to provide a central area where factual information can be obtained. Reporters receive the facts from such an information center without interfering with the suppression activity on the fireline. Access to the fireline activity is not denied the press, but the central point for information somewhat lessens the desire to get out on the fireline, except for photographers.

The following comment received from a national wire service while we were closing down the information center sums up the "thank you's" received from the press, "Until the past few years we had to get our fire information from some worker on the fire, 'phone a lookout station, or take comments from a passing motorist. The size of the fire would vary from 1,000 acres to 10,000 acres according to which newspaper you read."

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproductions. Please therefore submit well-drawn tracings instead of prints.

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FIRE CONTROL NOTES

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A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 21 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (October 17, 1958).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1960

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DEVELOPING A MEASURE FOR VARIOUS MAN-CAUSED FIRE RISKS

CRAIG C. CHANDLER
Forester, Pacific Southwest Forest & Range Experiment Station, U. S. Forest Service

One of the first, and toughest, jobs to be faced in fire control planning is developing a balanced fire prevention program. Funds and effort have to be apportioned between administrative units that have entirely different patterns of use, and within each unit prevention activities must be divided among all the various risks that contribute to man-caused fires. Achieving a truly balanced prevention program is not easy since the units may vary, not only in the amount of use each receives, but also in the kind of use, the severity of the fire season, the fuel hazards, and the efficiency with which present prevention funds are applied. Some method of compensating for each of these factors must be found to determine the relative risk of fire between two areas or between two unlike uses on the same area.

One way of combining all these various factors is to base prevention planning on actual fire occurrence. Since man-caused fires are the one direct measure of prevention failure, plans based on past fire occurrence automatically provide strengthened prevention effort for those areas and problems that have been shown to be either critical in importance or weak spots in the previous prevention plan.

But past fire occurrence has two serious disadvantages as the sole guide to prevention planning. First, you are planning to meet yesterday's problems. If you use a long enough period of record to eliminate weather fluctuations, then the plans will not represent current forest use and today's risks. On the other hand, if you use only statistics for the previous 1 or 2 years, then any real differences between areas or risks may be obscured by transient differences in weather.

The second objection to the sole use of past fire records is that good performance may be penalized and sloppy work rewarded. When two units are exposed to identical risks, then the one doing the best prevention job has the least number of man-caused fires. But if you take fire occurrence as the guide to prevention needs, the area with the worst record could get the major share of the funds. When carried to extremes, the use of past fire records to allocate prevention funds can lead to juggling of statistical vs. nonstatistical fires to the point where the records themselves become virtually meaningless.

Since the whole aim of forest fire prevention is to reduce the chance of man-caused fires starting, the ideal base for fire prevention planning would be direct measurements of risk (defined as the chance of a fire starting because of the presence and activity of causative agents). Unfortunately, although we can measure the presence and activity of causative agents, it is impossible to find a common denominator for such diverse agents as diesel locomotives and bird watchers without ending up back among past fire records to determine how many fires are caused by each group. Thus there would seem to be no advantage in using fire statistics to measure risk over using fire statistics directly to measure prevention needs.

Actually, though, there are several good reasons for taking the indirect approach and attempting to measure risk. Once the relative risk of fires starting from various causative agents has been established, you can plan prevention programs based on the expected future change in forest use. Planning need not be keyed to the problems of last year or the past decade. Second, you need not analyze data separately by districts or administrative units; therefore, the pooled statistics offer a broader statistical base, and any desired statistical accuracy can be achieved with fewer past years or records. Also, since risk is determined from regional averages rather than from fire occurrence on individual units, there is less pressure to manipulate fire records to show a prevention need, and greater uniformity in fire statistics should result.

How can risk be measured from data on fire occurrence? As mentioned previously, fire occurrence depends not only on the presence and activity of causative agents (risk), but also on weather and fuels (hazard) as well as the effectiveness of prevention activity. Therefore, any system of risk rating must compensate for differences in hazard and prevention effectiveness. Once this has been done, the corrected fire occurrence figures will provide an accurate index of the relative risk of different areas or different fire starting agents.

How can fire occurrence figures be corrected for weather?[1] The ideal method of measuring weather variables for use in developing a risk rating would be through an ignition index designed specifically for that purpose. However, fire danger rating systems based on rate of spread may be used as acceptable, though imperfect, substitutes. Whatever system is used, weather records must be available for the full period of fire occurrence, and not just for some arbitrary "fire season" of 2 or 3 months.

What about fuels? An index of fuels to be used in risk rating should be based on the relative ignitability of standard fuel types under specified weather conditions. Although no such fuel classifications have ever been devised, fuel maps based on rate of spread criteria such as Hornby's or on flammability zones can be used without serious error. It should be noted that a fuel index based on analysis of fire incidence by fuel types cannot validly be used in preparing a risk rating system. Forest use varies markedly by fuel types. The number of starts represents both inherent flammability differences and differences in risk, and these effects cannot be separated.

---

[1] The material that follows is taken from *Risk Rating For Fire Prevention Planning*, by C. C. Chandler, accepted for publication by the Journal of Forestry.

In spite of long and continued efforts, no one yet has devised a single yardstick to measure directly the effectiveness of the many and varied kinds of prevention effort practiced on a single prevention district. We can measure the miles of fireproofed roadside and the number of campers whom a patrolman has contacted, but we cannot equate the one against the other. Therefore, risk rating is only possible by removing prevention efficiency as a factor in determining fire incidence. Although this cannot be actually done, it is possible to determine fire occurrence, weather, fuels, and forest use over a short time period and to consider prevention efficiency as a constant.

In the California Region, where both the emphasis on prevention and forest use have been increasing geometrically, one year was the time period considered. In areas of greater stability, a longer time period, and hence a broader statistical base, could be used. Under these conditions, we can compare the relative risk of various types of forest use under the prevailing level of prevention effort. The comparison will be valid unless prevention efficiency is directly correlated with weather, fuels, or use. This later hypothesis can be tested statistically; in the California Region there was no such correlation.

Once all the necessary data on fire incidence, fuels, weather, and forest use have been compiled, the development of a risk rating becomes merely mechanical. For each area, fire incidence is corrected for weather and fuels, and regression equations are obtained between the resultant values and the various combinations of forest use. This work can be done most rapidly by high-speed computers, but if computer services are unavailable, rank order correlation can be used for rapid initial selection of variables. Using the regressions with the highest correlation coefficients, it is possible to compare the risk of fires from any particular type and level of forest use against any other use, or to compare the total risk between areas with unlike uses.

Two words of caution are necessary regarding procedures. First, regressions must be determined separately for each category of fire incidence. Certain kinds of forest use are highly correlated with fuels and weather. When all uses are lumped together, these intercorrelations get buried and the multiple regressions obtained have limited applicability and often certain nonsense answers. Second, testing must not be limited to linear regressions. It has become standard practice to show that the amount of forest use has increased faster than the number of fires and to attribute the difference to active fire prevention. But there is every reason to expect that the number of fires will not vary linearly with forest use regardless of fire prevention activities.

Perhaps this can be best illustrated by use of an example: If two hunters are camped within sight of each other, each tends to be more careful in his camping habits than he would be if unobserved. Further, there is a better chance that an incipient fire starting in either camp will be discovered and extinguished by one of the men themselves. Therefore, the number of fires to be expected when the number of hunters increases from 1 to 2 is something less than twice the number to be expected from a single hunter. Furthermore, there eventually comes a point where increasing the amount of use on an area actually decreases the number of fires. In a highly used area such as Yosemite Valley, potential fuels are trampled into the dirt, and it is impossible to drop a match without someone stepping on it.

One word of caution is also necessary regarding the interpretation and limitations of risk ratings. Although a risk rating gives a true picture of the relative risk between uses or between areas, it is valid only for one particular level of prevention effort. If the level of prevention effort is changed, or if emphasis is shifted from one type of risk to another, the ratings will cease to be applicable as soon as the change in emphasis becomes effective. To illustrate, if a particular forest finds that hunters represent three times the risk of loggers, but that prevention effort has been divided equally between the two, the forest may decide to increase the number of hunter patrols at the expense of logging inspections. In this event, assuming that the action is effective, the hunter fire problem will decrease while the logging fire problem gets worse. Until some sound method of predicting prevention effectiveness is devised, risk ratings will always be of transitory value.

Although data from the California Region risk rating will be published in connection with the Regional Fire Planning Synopsis, some of the results of this study may be of interest to illustrate the kind of information obtainable by a risk rating. In the analysis for the California Region we found that—

One-quarter of our man-caused fires would not have started if all roadsides had been fireproofed for a distance of 50 feet.

Hunters cause 3 to 7 times as many fires, man-for-man, as any other group of recreationists.

We average only one logging fire for every 30 million feet cut on national-forest land.

As many fires are started by powerlines as by picnickers, and that distribution lines, rather than main lines are the biggest problems.

Fishermen start more fires than either railroads or incendiarists, and that hunters start more fires than both groups combined.

On one forest with 100 miles of railroad, 43 percent of the railroad fires in the past 10 years have started along a single 5-mile stretch of track.

The threat of fires from visitors in regularly maintained, improved campgrounds is negligible. Our problem is the "boondock" camper.

FIRE FIGHTING WITH HELICOPTERS

Unit Area Control Planning and Development

JAMES L. MURPHY
Forester, Payette National Forest

Almost $2 per minute; over $100 per hour; on a project fire, maybe $1,000 a day. That's what the small helicopter could cost a resource management unit. No wonder that many national forests and other agency units are turning to unit area control in helicopter management. It's the only way to make every one of those 2-dollar minutes count.

Most foresters are familiar with the concept of unit area control in timber management. It is an intensive technique applied to specific units to attain a particular objective. In this case it is an efficient and economic helicopter attack or helitack operation. This paper deals with unit area planning for helitack and the development that might be necessary to achieve the planned control.

Before any actual helitack planning is done, the use of the helicopter must be justified. Unit area managers should ask themselves these questions:

1. Is there a real problem that helitack might solve?
    a. Is fire business heavy?
    b. Are high resource values at stake?
2. Can the existing organization handle the fire problem?
    a. Is the ground coverage adequate?
    b. Is elapsed travel time to fire attack excessive?
3. Can helitack handle the fire problem?
    a. Will the cost of helitack be less than the cost of expanding the existing ground fire organization?
    b. Is an approved helicopter and pilot available?
    c. Can the helicopter operate safely and dependably under the unit's conditions of density altitude (elevations corrected for temperature), wind, topography, and cover types?

If helitack is still justified after considering these questions, then helitack planning is the next step.

PLANNING FOR HELITACK

Helitack probably will never completely replace the ground fire organization. Helicopters and helitack crews have proved to be only another tool to strengthen the existing fire organization. Most helitack planning and unit area development is based upon the existing ground crews, equipment, and facilities.

Determination of helitack priority zones.—Areas where helitack will be the quickest and most effective means of attack must be determined. Areas with presently adequate ground coverage may not be included in helitack zones. For helispot construction priorities and manning and dispatching guides, specific priority zones should be determined within the broad helitack zone. One method makes use of four map overlays:

1. Ground crew coverage adequate to keep within hour control standards.
2. Fire occurrence pattern over past 10-20 years.
3. Hazard zones based upon cover types.
4. Priority zones. Area covered by ground crews is eliminated. Hazard and fire occurrence overlays are combined into high, medium, or low priorities.

The first three overlays, on top of each other on a tracing table, determine the fourth. Special problem areas may be thrown into high priority zones, and the zone boundaries smoothed out on the basis of local experience.

Helicopter coverage.—Permanent bases of helicopter operation called base heliports must be located where the maximum amount of coverage over the unit is possible. Four time increments should be used (fig. 1):

1. Getaway time (experience on time tests).
2. Flight time from base heliport to a spot over a supposed fire (a mile per minute for most small helicopters).

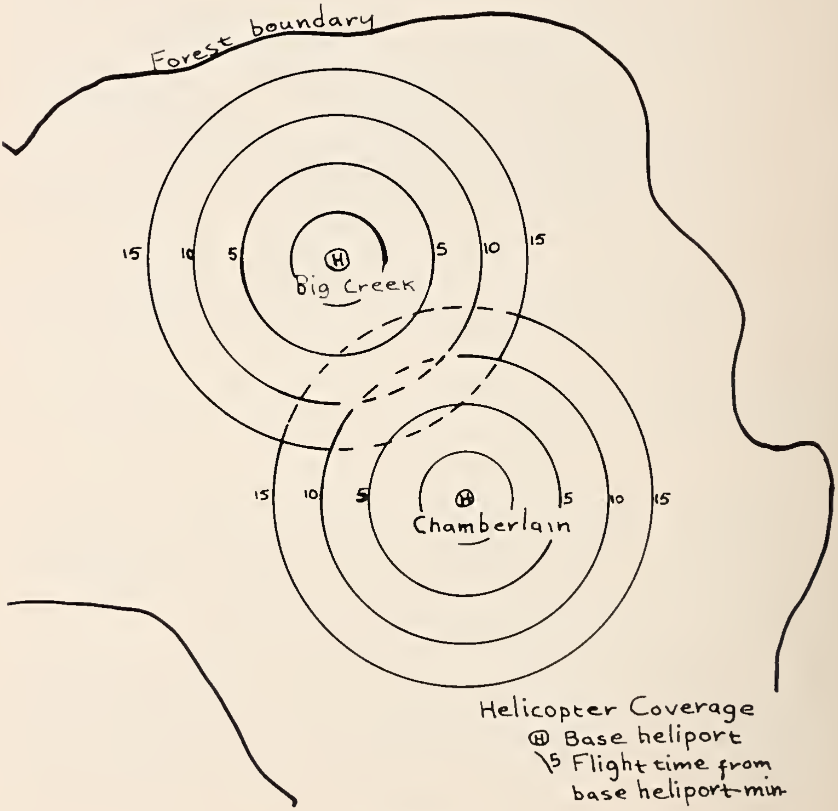

FIGURE 1.

3. Reconnaissance-to-touchdown time, or an average time to reconnoiter the fire, report its location and condition, select a landing spot, or helijump spot, and put the firemen on the ground.
4. Ground travel time from landing spot to fire.

The total of these time increments should be *less than the hour control standard set up for the unit.*

Establishing base heliports.—Important points to consider are accessibility by road, size, hazards such as powerlines and trees, prevailing winds, higher elevations so as to eliminate uphill helicopter climbs to fires, dropoff for takeoffs at elevations above 5,000 feet, dustproofing, heliport identification. Base heliports must be furnished with operational facilities such as wind socks and fire extinguishers, and safety regulations posted. Helitack crew equipment and helicopter fire accessories should be cached at base heliports.

Location of reinforcement base heliports.—Helicopter rendezvous points, or reinforcement base heliports, should be located on the edge of helitack zones for the quickest followup action. Reinforcement helitack crews and equipment are dispatched to these heliports for aerial move up action. Reinforcement base heliports may be generally located as follows (fig. 2):

1. Locate helitack zones and nearest ground crew to that zone.
2. Calculate, on the basis of time increments already described, the time for the helicopter to deliver the fireman to a spot near the fire. Add time for the helicopter to be in the air again.
3. Calculate how far along the most direct route of travel to the fire area the reinforcement crew will be by the time the helicopter is in the air again at the fire. This should mark the general area where the base heliport should be located.
4. Determine the specifc location for the heliport by observing points mentioned under establishing base heliports. *Try to get these heliports on high points, out of the canyons.*

Helitack flight and hazard map.—Flight-times-at-a-glance and flying hazards to be encountered enroute are important in planning a mission. A master flight map might include—

1. Flight time in 5-minute intervals.
2. Hazard areas, such as power and telephone lines, smokestacks, and consistently turbulent areas.
3. Landing and refueling areas.

Helispot location.—An adequate helicopter landing spot, or helispot, network is basic to the most efficient use of the helicopter. Fire initial attack will require the most intensive coverage. On the basis of this fire initial attack network, other projects, such as timber and engineering, may be planned. Suggested steps for helispot location are—

1. Locate helitack priority zones. During a reconnaissance flight locate potential helispots in high priority helitack zones first. Locate and mark natural helispots during flight.
2. Locate natural and potential helispots on map.

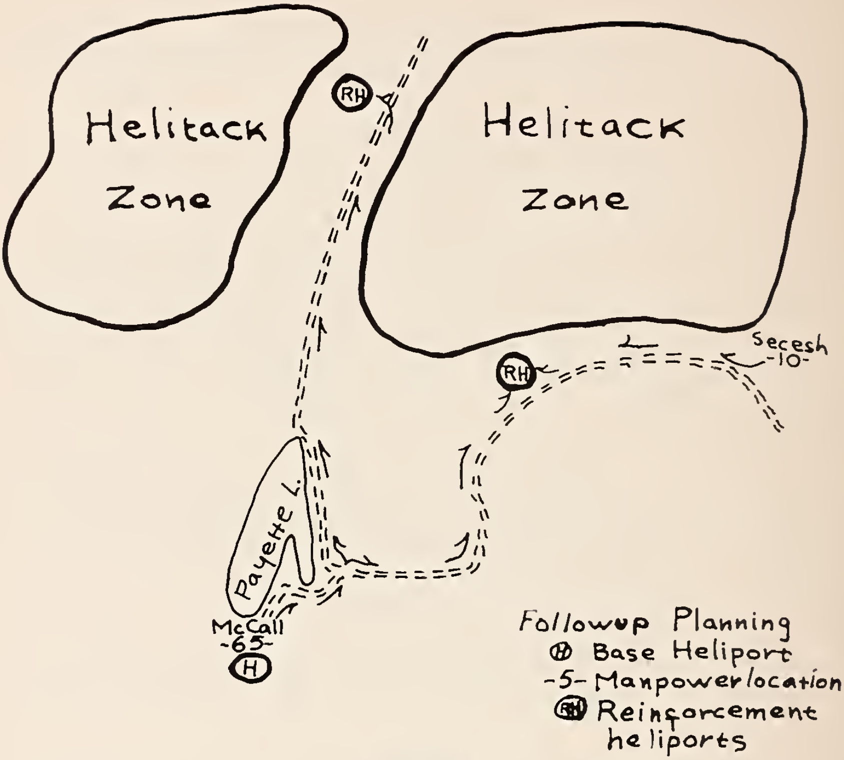

FIGURE 2.

3. Figure coverage from each helispot within the hour control standard. Use initial attack time increments from base heliport to landing.
4. Subtract total helicopter time from hour control standard. This leaves the time left for the man to hike. Plot this time in terms of his distance per time unit. Each helispot will have a rough circle of coverage around it. A large ½-inch base map used in this manner will give an extensive idea of coverage (fig. 3). For intensive planning use topographic maps and vary hiking coverage with the specific topography.
5. From above map work determine areas lacking helispot coverage and locate possible helispots in these areas.

Helispot construction and maintenance.—Plan helispot construction so as to use a minimum of flight time. Be sure men are oriented in safety and helispot construction principles before beginning project. Check with the pilot for ship limitations. Try to combine projects and use contributed labor where possible.

Inspect helispots each year if possible. Perform maintenance currently. Combine it with other projects so as to keep flying time to a minimum.

All helispots should be visible from the air and numbered. Records of the location of each helispot and its description and hazards should be filed at key stations.

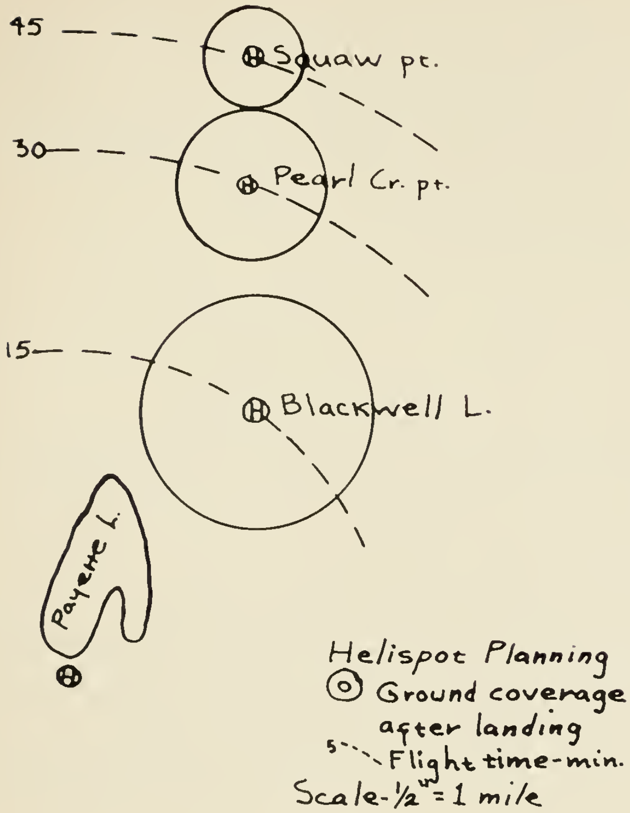

FIGURE 3.

TRAINING FOR HELITACK

Helitack crews, helitack reinforcement crews, and other personnel participating in helitack should be trained *as soon as possible* by a qualified air attack man and the pilot. Helicopter safety, helicopter operation, helitack equipment use and maintenance; helitack skills such as helispot location and construction, helijumping, etc. should be stressed. Ground crews should be trained and equipped to function as helitack reinforcement crews. These crews will respond to helicopter rendezvous points to be picked up by the helicopter and ferried in to the fire or fires.

HELICOPTER USE PLAN

The actual use of the helicopter must be managed intensively for the most effective and economic operation. A helicopter use plan is important and should include the following:

1. Use policy.
2. Permissible uses.
3. Priority of uses.

4. Guides for the use of helicopter accessories.
5. Communications plan.
6. Helitack manning plan. Helicopter and crew may be assigned to various base heliports in response to fire danger.
7. Fire dispatching plan. Helitack must be integrated with other air and ground attack.
8. Helitack fire mobilization plan. Initial attack and followup procedures on small fires. Large fire procedures.
9. Air control organization and plan.
10. Nonfire uses of the helicopter.
11. Operational forms and records.

☆ ☆ ☆

Send Them, But Safely

Safety reminders are flashed before us in many ways and in numerous places. One manufacturer reminds his employees by sounding the plant whistle in the middle of the shift. But the fire control job is unique, and many of these devices do not work for us. We cannot always lean on the boss for we may be on our own; neither can we always look to the safety officer. It remains for every person in the organization to carry a share of responsibility.

Take any fire in the early stages. There are several men on the blaze, more are enroute, and still others are being ordered by the dispatcher. This very busy man may be the key safety man until the fire boss, or someone in authority, arrives. If he will just "cue-in" the fellows he is sending with a vital word, a short phrase, or a brief snatch of information, it may mean all the difference in both safety and control of the fire.

For example, the dispatcher may know of a road hazard involving "fresh oil on 3 miles of Highway 13." A detour or bridge load limitation might alter travel instructions. Several fire vehicles may be converging on a fire over narrow, winding roads. Accidents could happen, serious delays occur. Perhaps the dispatcher should exercise his authority and establish a temporary road control.

The dispatcher may receive an "outage" report from the power company; several minutes later, the report of a fire in the same general area. His radio message to the first crews might be, "Respond to a fire at the intersection of Highway 2 and the high line. Power outage also reported." This will alert the pumper crew enroute to be cautious in the use of water on a fire perimeter that may be near a downed high-voltage line in the immediate area.

Air tankers and smokejumpers may be called from several airports. Simultaneous responses could cause complications. There must be coordination in the air to work safely. The dispatcher can ease this situation by an airnet announcement "Air tanker three nine off Red Bend at one-one and aircraft two eight off Willow Cove at one-three, both estimating the Red Mountain fire in seventeen minutes."

These cases, as every fireman knows, can be multiplied indefinitely but the need for safety is the same. Competition for the airways and ether waves is critical even in the woods. A safety signal message should not, and need not, be lengthy. The dispatcher's desk is a beehive of activity but he must be alert to see and act on some vital safety measure.—A. VIRGIL SHOEMAKER, *Fire Equipment Specialist, Arcadia Equipment Development Center.*

PLANNING THE BLACK HILLS HELITACK PROGRAM

Kenneth C. Scholz, *Fire Control Officer* and
Robert F. Kruckeberg, *Forester, Black Hills National Forest*

The Black Hills National Forest, comprising one and one-half million acres in the western part of South Dakota and eastern Wyoming, was selected for the first aerial project in the Rocky Mountain Region. The terrain varies from nearly flat to steep and rocky, with gently rolling areas predominant. Elevations range from about 3,500 to 7,242 feet. The vegetative type over the entire forest is a nearly pure uneven age ponderosa pine stand with dense patches of "dog hair" reproduction interspersed throughout. A grass cover is present under all but the most dense stands (fig. 1).

Lightning is the principal cause of the large number of fires which occur annually throughout the Black Hills. Over the past 10 years there has been an average of 177 fires per year.

An excellent detection system; well-trained ground forces; numerous roads and fire trails (very few areas are inaccessible to 4-wheel-drive pumper units) were some of the conditions present when the Helitack program was set up to determine if a helicopter and a small crew of highly trained men could more effectively meet the desired attack time than additional ground manning.

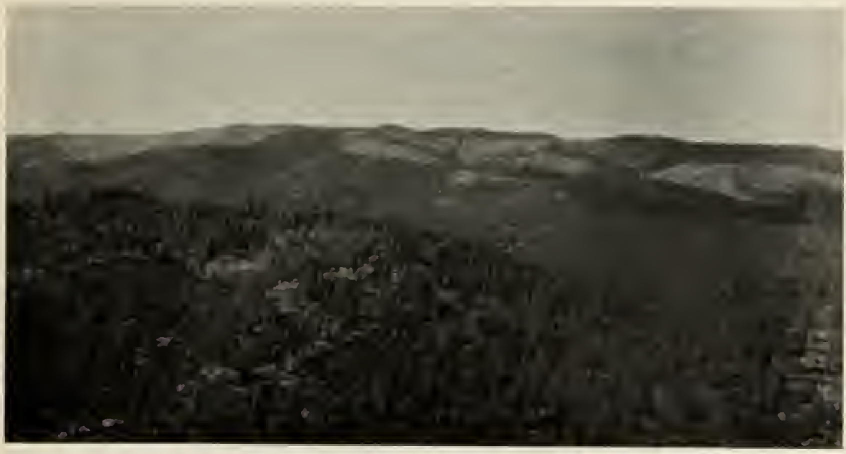

Figure 1.—Typical terrain in the Black Hills showing rolling hills and heavy timber type. Close inspection usually revealed small parks large enough to accommodate a small helicopter.

Many considerations must be evaluated before setting up a helicopter operation—questions that will serve to point out whether it is feasible and practical. Once it has been determined that a helitack crew is to be set up, decisions relative to base and field heliports, helispots, crew and training facilities, helitack priority zones, helicopter use plans, and many other operational decisions must be made.

Heliports.—A centrally located base heliport was selected at a high enough elevation (5,040 feet) to provide a downhill run to most areas and a safe and efficient operation for the helicopter. The site selected for the base heliport included a large building well suited for a hangar and a fenced in yard ideal for a landing pad (fig. 2). The pad was oiled to prevent dust blowing and marked for positive identification from the air (fig. 3). Alternate or secondary heliports were designated on four districts and served primarily as refueling points. No work was required on these sites except marking a touchdown pad to keep the areas clear.

Numerous parks and openings over a large part of the forest provided "built in" helispots (fig. 4). Areas that offered no natural landing spots were in zones of light fire occurrence so it was decided to go slow in helispot construction. This decision proved well founded, at least for the first year, as only three fires this year required more than a 15-minute walk from landing point to fire. Future helispot construction will be carried out in high priority areas and in other locations needing them.

Crew organization.—A six-man crew composed of an assistant ranger to serve as foreman and five experienced forest workers as crewmen were selected. Since no experience qualifications had been established for this type of position, the men were required to meet the standards for smokejumpers plus some others sug-

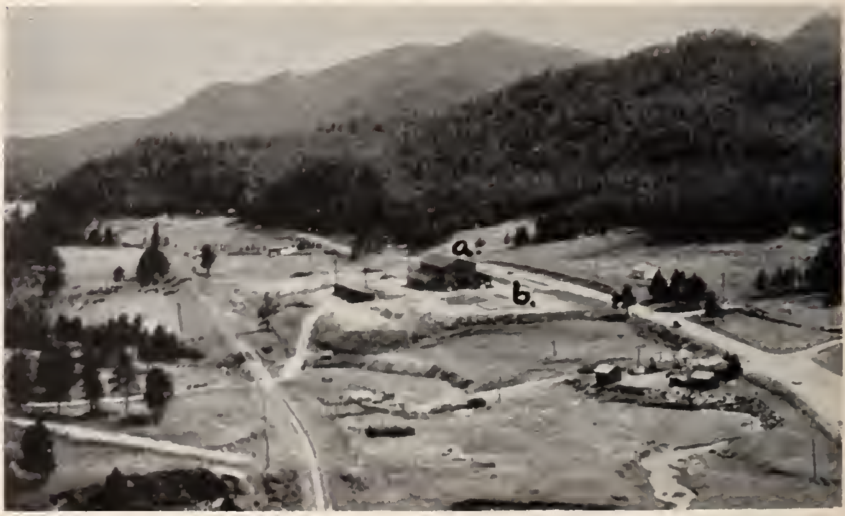

FIGURE 2.—Base Heliport at Hill City, S. Dak. Elevation 5,040 feet. *a*, Hangar; *b*, touchdown pad and safety zone, 150 by 300 feet.

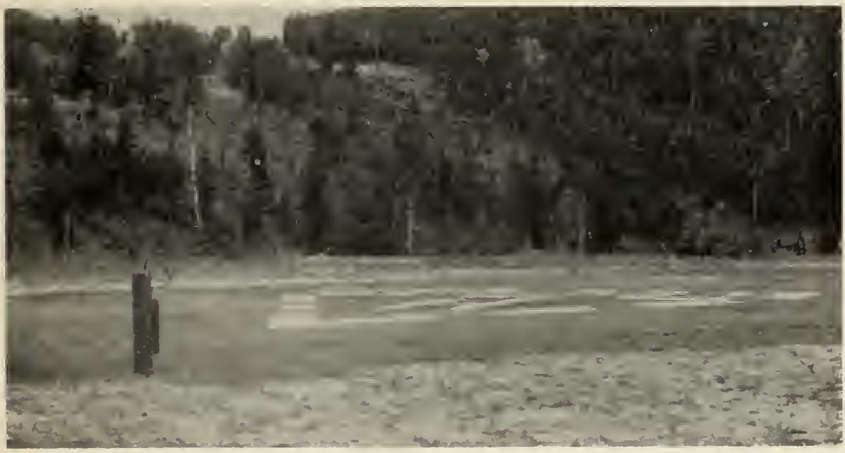

FIGURE 3.—Hill City Heliport touchdown pad marked with standard F.A.A. Heliport marker.

gested by the California Region guides. Training began 2 weeks before the helicopter arrived and was completed by the end of the fourth week, although the crew was operational when the ship arrived. Throughout the season, the crew worked a split workweek with four men on duty every day and the other two readily available if needed.

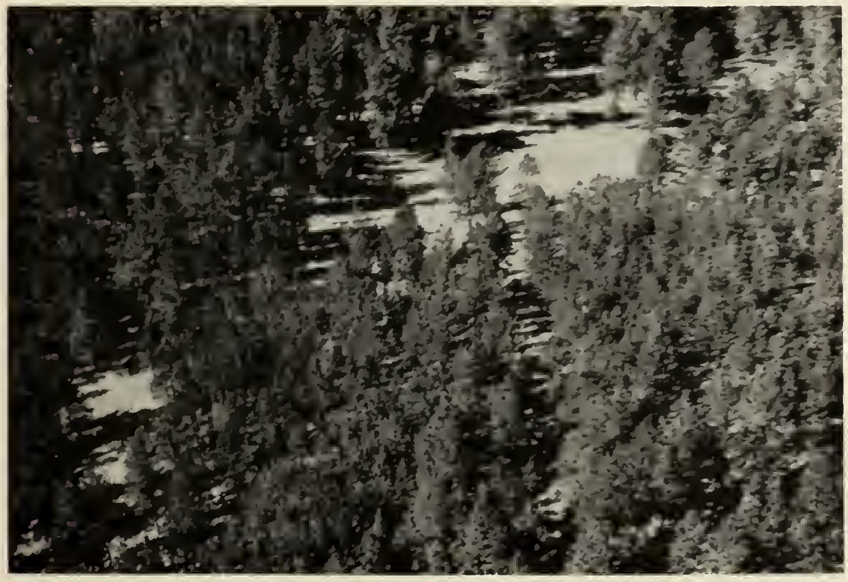

FIGURE 4.—A natural helispot typical of the many that were not visible from a distance but which showed up when the helicopter was nearly overhead.

Equipment.—The contract was awarded early in March for a Bell 47 G-2 with a 100-hour guarantee for the period June 1 through October 31. Five bids were received, varying from the low bid of $93.50 per flying hour to a high of $227 per hour for the same model. The low bid was accepted and the contract ship did an excellent job.

Many of the facilities needed at the base heliport were constructed by the helitack crew at no cost other than labor. The large building at the base site supplied many of the facilities required: hangar, work area, office space, ready room.

Helitack priority zones were not too important this first season as the helicopter was to be dispatched to all fires possible within the primary initial attack zone (a 20-mile radius from the base heliport) for the purpose of determining what it could do and what its limitations were. All dispatching was done by the forest dispatcher.

Finance.—The Forest is made up of eleven districts. The presuppression manning on each of the districts in the project area was reduced to help finance the helitack unit. This meant that in lieu of district crews having to maintain a constant standby, the helicopter crew would supply the initial action, with the district crews coming in as soon as possible for reinforcement. Other functions were invited to use the helicopter during periods of low fire danger. About 15 hours were flown to spray weeds and to observe and record insect infestations.

RESULTS—1959

During the fire season, 192 fires occurred on the forest. One hundred eighty of these occurred on the 10 districts on which the helicopter was used. The ship was dispatched on 84 calls; 67 of which were fires, 14 were false alarms, and 3 were aerial detection flights. Of the 67 fires having helicopter action, 57 had men placed on them by helicopter, 43 of which were initial attack. On 10 fires, the helicopter was used only for scouting or the fire was manned on arrival. On at least 10 of the fires that were first manned by the helitack crew, the rapid attack was the deciding factor in holding the fires to small size.

Besides being used for initial attack on small fires, the helicopter proved valuable for guiding ground crews into fires, as a communications link between crews on the fire and the dispatcher or lookout, for scouting and reconnaissance and many other functions. The ship proved to be of extreme value on the two project fires that occurred on the forest this year.

During the height of the fire season, the helicopter was out of commission for 9 days (not in one stretch), and 38 fires occurred. This was convincing evidence that it is unwise to "put all your eggs in one basket."

SUMMARY

Successful helitack programs have been in operation for several years. In setting up the Black Hills Helitack Program, our first step was to review all the literature available on helicopter operations and helitack programs. This provided us with an outline for analyzing our particular situation.

Basic analysis of the need or feasibility of using a helicopter:

1. Fire occurrence. Do enough fires occur in the initial attack area so that a helicopter can economically be used to provide transportation for initial attack crews?
2. Values protected. Are values of the resource protected high enough to justify use of helitack?
3. Hour control. Will a helicopter provide hour control more economically than additional manning?
4. Detection and rate of spread. Are fires spotted quickly enough so that two men delivered by helicopter can reasonably be expected to hold down the rate of spread until reinforcements arrive?
5. Terrain features. Are topography and vegetative cover such that the helicopter can deliver men reasonably close to the fire so that hour control requirements can be met?
6. Financing. Can existing financing absorb the minimum operational costs of a helitack program?

Setting up a helitack program:

1. Locate the base heliport as strategically as possible with emphasis on central location and logistics.
2. Determine the minimum helicopter performance requirements that will do the helitack job in the most efficient manner.
3. Determine the helicopter contract period and what minimum flying hour guarantee would make possible a profitable operation for the contractor.
4. Depending on type of ship, plan a system of alternate heliports to provide for maximum efficiency.
5. Select and start training the helitack crew prior to arrival of the helicopter.
6. Provide adequate communications, supply, and facilities.
7. Develop dispatching plan and use policy to coordinate the helitack organization into the existing administrative program.
8. Develop detailed financial plan.

After the helicopter arrives:

1. Orient and train the pilot in helitack techniques, emphasizing safe practices.
2. Orient and train the crew in helicopter procedure.
3. Integrate the helicopter into the fire control organization by giving the ground crews training and demonstration sessions.
4. Revise and adapt the planning as necessary to fully utilize the new procedures.

Records and reports:

1. Plan for complete and accurate cost and accomplishment reporting by individual fires.
2. Plan for an evaluation both by individual fires and for the full season.

PLANNING THE LOCATION OF FIRE DANGER STATIONS

James B. Tucker
Meteorologist, Division of Fire Control
Washington State Department of Natural Resources

Assuming that the primary function of a fire danger station is to measure weather elements that will give an indication of fire risk and its rate of spread and intensity if started, then the location of the station must be such that the elements measured will be representative of the area. Also, the location and installation of the fire danger station should conform to certain rules in order that a basis for comparison exist between stations. With this in mind, there should be little variation in the basic standards for location of fire danger stations between areas, as well as between districts, forests, agencies, or States.

Fire danger stations should be located in the higher hazard areas in each district, but duplication of stations in the same area is unnecessary. Where no fire danger stations exist in high hazard areas, either a station should be established or a correlation should be developed between these areas and existing fire danger stations. Temporary stations can be set up with portable weather stations to collect the data necessary for the development of these correlations. Automatic weather stations can be utilized in the future to effect a saving in time and personnel.

Because current practices entail close contact with the post of duty, the distance between observer and fire danger station is of prime importance. This should be such that the observer need not be gone more than 15 minutes or over 100 yards. Careful attention should be given to local influences. Avoid swampy ground or proximity to dusty or large paved areas.

Correct exposure of the wind instruments seems to be most difficult to obtain, and optimum height excites the greatest controversy. Table 1 gives the approximate effect of obstructions on wind flow.

TABLE 1.—*Typical values of horizontal wind speed behind barriers of different densities; downwind distances measured in terms of height (h) of barrier*[1]

	Percent of "Free" Wind Speed When Distance of Barrier Downwind Is—								
Type of barrier	0h	2h	5h	10h	15h	20h	25h	30h	40h
Open (density about 30 percent)	90	80	70	75	85	90	95	100	100
Medium (density about 50 percent)	40	25	20	25	50	60	75	90	100
Dense (density about 100 percent)	0	20	40	65	80	85	95	100	100

[1] Gloyne, R. W. Some Effects of Shelter-belts and Wind Breaks. The Meteorological Magazine 84(999): 272-81. 1955.

Numerous studies concerned with wind profiles reveal that wind speed increases rapidly for the first 20 feet above the top of the ground cover, whether trees, brush, or grass, then levels off. It would appear, therefore, that the best height is 20 feet above the general ground cover. However, if this means that the anemometer must be at a height of say 100 feet, then it seems that elevation has become a factor. Is the wind speed obtained at this height representative of the wind which will be involved in the spread of a fire in that area? The Washington State Department of Natural Resources has, we believe, taken a realistic approach to the problem, by setting the height of the wind instruments at 20 feet above the ground and as far away as possible from all obstructions. In any case, the minimum horizontal distance should be no closer than twice the height of the obstruction. Locations on roofs and lookout towers are not advisable.

It is desirable to locate the other instruments with the anemometer and wind vane, but this is not necessary. Regardless, the fuel sticks should be exposed to full sunshine throughout the day, and both the fuel sticks and instrument shelter should be located where they will receive an unobstructed flow of wind. Instruments should be installed according to U. S. Weather Bureau standards or as prescribed in fire control manuals. These manuals vary slightly in detail for various sections of the country.

MACHINES VERSUS MANPOWER IN INITIAL ATTACK

Joseph Couch, Jr.
Forester, Division of Fire Control, Southern Region, U. S. Forest Service

Fire planners have the responsibility of determining the most effective, economical combination of equipment and manpower required to meet initial attack objectives.

In the beginning, any planning must consider the optimum initial attack system desired. Such a system should satisfy the following basic principles: (1) Have strength, energy, and sufficient flexibility to handle changing fuel (fig. 1), risk, hazard, and weather conditions; (2) require a minimum of servicing during a mission; (3) have maximum coverage for the area and task involved; (4) be economically justifiable; and (5) perform all tasks within elapsed time requirements.

The Southern Region of the U. S. Forest Service has developed an initial attack and suppression system based on the use of machines. This system operates in more than 70 percent of the regional area. On the basis of a 10-year fire fighting record that has averaged 1,800 fires per year, we have made certain observations on the applicability of machines to the basic principles outlined above.

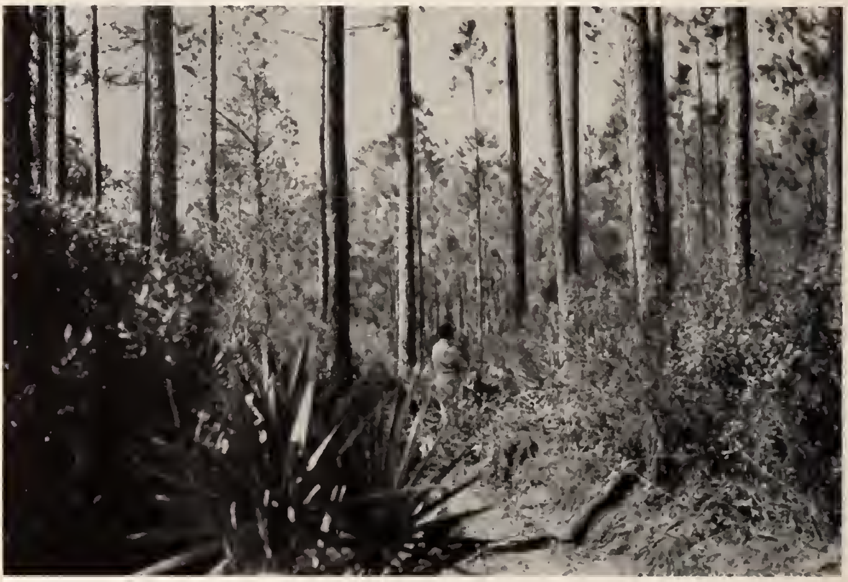

FIGURE 1.—Typical forest fuel in the Coastal Plains, southern United States. Fires in this fuel spread at the average rate of 80 chains perimeter per hour.

(1) The advantages of machines lie in their strength, which can be made proportionate to the job at hand; their continuous energy and service; and their diversity of types and uses. Manpower strength, on the other hand, is fixed by that of the individual whose energy is unpredictable and periodic; its capacity is limited to the number of tools and the severity of the fire situation. A bulldozer may fell and mop up a burning snag in 15 minutes, whereas manpower would be unable to even attack the job within the burning period. Furthermore, the machine has the endurance to repeatedly and continuously perform such tasks. One tractor-plow unit crew suppressed 10 fires per day; a larger handtool crew could handle only 2 similar fires. In an average worst-fire-danger day, machine-fought fires averaged 27 acres per fire, while the manpower-fought fires reached 94 acres per fire in the same area. Also, 4 percent of the manpower-suppressed fires reached class E size compared with 0.3 percent for machine-suppressed fires.

(2) The comparatively small amount of servicing required by most mechanical equipment gives it a tremendous advantage over manpower with handtools. Properly selected machines can move to a fire, put it out, and return to base with a minimum of servicing from auxiliary facilities. A tractor-plow with a 3-man crew forms a complete initial attack unit. Either alone or in combination with other like units it handles 90 percent of the fires occurring in the Coastal Plains and Piedmont areas. Auxiliary equipment for these machines are the slipon and small tractor-tanker units. This contrasts with an initial attack system that is all or part manpower and requires warehousing, transportation, field camp, food, and sleeping equipment just to service human energy only.

(3) Machines offer more extensive coverage in two ways. From an economic standpoint, stronger initial attack can be launched on more acres per mechanical unit. From the standpoint of energy, machines can handle initial attack on more fires and perform a greater variety of tasks than manpower. Our records show that one tractor-plow unit with a 3-man crew accomplished initial attack objectives on an average of 75,000 acres with a better record than was obtained during the Civilian Conservation Corps days with 50 men for 10,000 acres. Mechanized attack minimizes a difficulty which manpower finds serious; that is, line building through widely varying cover and fuel types. The tractor-plow can construct an average of 120 chains of line per hour through all varieties of fuel types in the Southern Region with the exception of swamp areas (fig. 2). Handtools in a like situation would require one or all of seven specific tools, and manpower would cover less than one chain per man-hour.

(4) Machines give us more protection per dollar expended, as is evident in the three preceding observations. They require less management, have other uses in forest work, and can be stored during periods of nonuse. In addition, the time required of fire officers for training fire crews is much less; thus, machines contribute to higher morale.

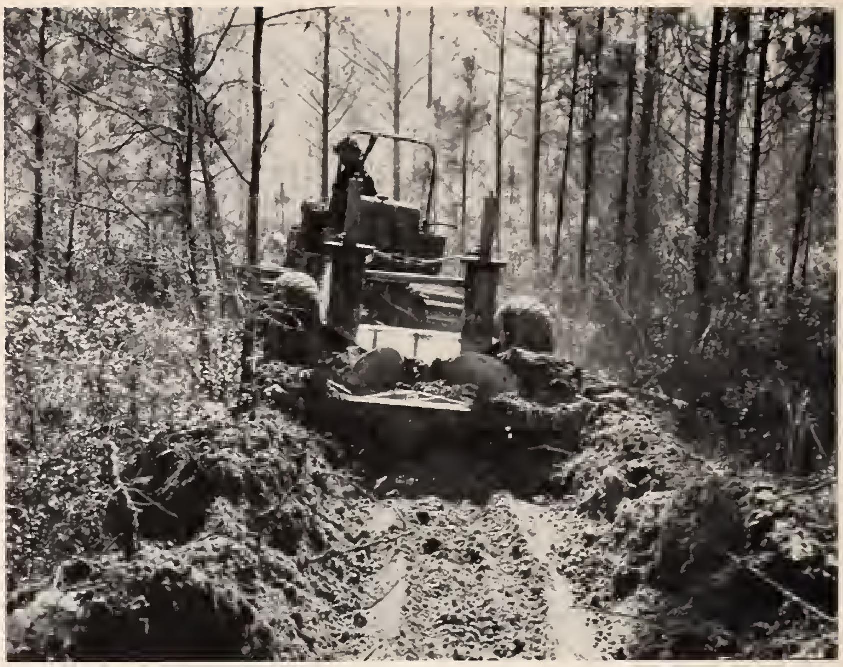

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FIGURE 2.—Mathis plow unit constructing 4-foot wide line to mineral soil at the rate of 150 chains per hour.

(5) We have learned that initial attack is much faster with machines than with trained handtool crews. Elapsed time studies on 600 fires using similar danger class days showed that the average fire, when reached by machine attack, covered 13 acres; when reached by handtool crews, 46 acres. Factors that favored machines were faster getaway time because fewer men were involved; generally faster travel; more flexibility because they were radio equipped; faster cross-country travel; and greater finesse in attacking the fire.

PLANNING FOR PUBLIC DETECTION

NED CURTIS
Assistant District Supervisor,
Michigan Department of Conservation

Today, the American public plays an integral role in forest fire detection. Statistics show that over 50 percent of all smokes are reported by an informed, fire-conscious public.

Such was not always the case in Michigan. Until some 30 years ago citizens displayed little concern over wildfires unless lives, communities, or valuable property were endangered. Lumbermen, after removing vast tracts of pine and hardwood, left the areas ripe for fires that swept through slash and second growth. Early settlers cleared the land for farming; many viewed the uncontrolled fires of the day as a useful tool for that purpose, disregarding or not thinking of the ultimate results. Pioneers in the field of forest fire prevention waged an uphill battle for many years. Michigan's first legislation regarding forest fire was enacted in 1817, but more than one hundred years passed before any serious effort was made to enforce the laws. Not until 1925 did Michigan have a burning permit law.

Gradually the public, not only in Michigan but throughout the Nation, began to realize the terrible price it was paying for uncontrolled forest and grass fires. Today, through the tireless efforts of the press, radio, TV, government agencies, and many civic groups, the people have better understanding of the principles of conservation. The vast majority now realizes and accepts its responsibility to future generations. Most citizens consider it their duty to report all fires immediately. This is borne out by the fact that over one-half of all fires in recent years were discovered and reported by local residents and travelers. The development of this sense of duty is largely a matter of education.

Never again can we afford to become complacent. All career conservationists have the unending task of keeping the public well informed and aware of existing forest fire danger. Experience has shown that an informed public will respond to an emergency.

Michigan forest fire officers continuously carry on certain practices which promote public responsibility in the detection of forest fires. Several of these practices are listed below:

1. Smokey Bear posters and other fire prevention materials are distributed systematically. Maps are maintained of poster locations and frequently reviewed to be sure that all key points, particularly entrances to hazardous areas, are covered. Posters are displayed in such places as gas stations, grocery stores, and sporting goods shops. On occasion, Boy Scout troops and other youth organizations have assisted by placing fire prevention displays in windows of business establishments.

2. A very important part of a forest fire officer's job involves working with the public in his assigned area. At meetings with various groups and individuals the officer constantly plans for better fire detection. Every effort is made to acquaint the public with the forest fire suppression system in effect in its locality. Persons are advised where to telephone in case of fire, and are impressed with the importance of acting fast when fires are small. Most telephone companies give emergency directory listings for forest fire equipment stations and telephone operators are trained to handle reports of forest fires.

3. The forest fire officer makes periodic checks with local keymen, business establishments, resort owners, and other cooperators to make sure that they have proper telephone listings. If a remote area lacks a communication system, he sets up a messenger plan with the inhabitants.

4. When the forest fire officer assists in formulating news articles or radio and television programs, he always stresses the importance of prompt reporting of forest fires by the public.

The average Michigan citizen is beginning to fully realize the huge stake he has in the out-of-doors. He is ready to do his part to "Keep America Green." It behooves us, in the field of conservation, to guide him accordingly.

PUBLIC FIRE DETECTION IN WISCONSIN

Leigh V. Hilliker
Supervisor, East Central and Southern Areas,
Wisconsin Conservation Department

In the spring of 1954, the Forest Protection Division of the Wisconsin Conservation Department launched a new, five-county forest protection district in central Wisconsin. The way had been cleared by petitions and hearings, changes in legislation authorizing an extensive[1] district or districts, and necessary surveys and investigations.

Extensive district #11 was added to the ten original intensive[1] districts and embodied a modified and more economical form of protection than was previously known in the State. Later, extensive district #12 was organized. Economy was to be gained through the use of fewer personnel, less detection and suppression equipment for a given area, some dependence on the local rural fire departments, and public assistance in detecting and reporting forest fires. Public detection was to be supplemented during high fire danger by contract airplane patrol and ground patrol. This contrasted with the lookout tower and State-owned telephone and radio systems of the intensive districts. The burning permit law was modified to require permits only during high danger periods, which were announced by posted signs and in local papers.

Because forest and wild land areas then averaged only 41 percent of the total land area in the five counties, expenditures for a lookout tower system were unwarranted, at least as a beginning. (This percentage is rapidly changing each year with the increase of forest plantings on marginal farmlands.) Then too, the airplane and television were being experimented with in some quarters as possible superior detection tools.

These considerations, coupled with a uniform dispersal of population and the desire for better protection, as evidenced by numerous petitions in preceding years, pointed up the possibilities for good public cooperation in detection of forest fires.

To become operative, a program involving public participation in detection requires communication facilities and a cooperating agency to relay calls.

The problem of communications was a weighty one. People must have inexpensive, fast, convenient, and familiar means of reporting fires locally or cooperation is ineffective. The local ranger was usually in the field on patrol, checking burning risks and hazards, fighting fires, or tending his many other duties, and thus unavailable at his office for a direct telephone call much of the time. Word of a fire would have to come to him over his mobile truck radio.

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[1] Described in Wisconsin Statutes 26.12.

Message relay agents for telephoned fire calls from individuals were found in the five county sheriff's offices. Through the inter-county radio net, manned 24 hours a day, the various sheriffs' offices relay calls to the Wautoma sheriff who, in turn, telephones them to the district ranger station. The district dispatcher contacts the local ranger on the forest protection radio which is on a separate channel.

This is the principal means of collecting and receiving fire calls from the public, but there are other methods. The signboard at the house of each State emergency fire warden, of which district #11 has 170, says "Report fires here" and, of course, people do just that. Many fire wardens are town chairmen who were the legally constituted town fire wardens before the forest protection district was organized. Calls reporting forest fires are also received through rural fire departments and relayed to the ranger. Certain groups of workers or professional men such as county traffic officers, highway patrolmen, and veterinarians cooperate with the local ranger. School children are advised by the ranger where and how to report fires. As he becomes better known in the community, more and more calls come directly to him at his home or office.

After the method of channeling fire calls was devised, the next job was to publicize it to gain the public's acceptance. At first, it was mandatory that the details of the plan be spread immediately to as many people in the new district as possible in the hope that some at least would start to function as fire detection cooperators. Later a more thorough and convincing job could be done through several media and personal contacts.

News was spread through the usual channels to the countryside. The State Conservation Commission rule setting up the new district and describing the boundaries was published in the official State newspapers. This rule, which has the effect of law, emphasizes that the Conservation Department is responsible for the recording and suppression of all forest, field, and marsh fires outside the limits of incorporated cities and villages. Newspapers, radio, TV, signboards, and posters outlined the details of the new laws and organization, including where and how to report forest fires. For example, special paperboard signs were printed and used on over 300 signpost locations throughout the district advising people to report fires to the sheriff's office. When burning permit requirements were in effect, these same signboards, which are located in various places, such as road intersections, town halls, and stores, carried notice of that fact. Some brief meetings were held where requested or required, as with fire departments, to explain details of operation.

However, the biggest, most difficult, and most time-consuming job still lay ahead; namely, selling acceptance of a forest fire protection program which prompts people to report wildfires and cooperate in prevention, suppression, and law enforcement. This requires grassroots education; its effectiveness is the test of final success. Among certain groups or individuals who, for various reasons, do not see eye to eye with the ranger on the business of forest fires, this education goes forward slowly—imperceptibly at times—but lasts indefinitely.

A person can be told that he should report forest fires, but if he believes that the land must be burned to kill grasshoppers or to produce blueberries or that grass fires do no damage or that woodland pastures must be burned each spring, his definition of a reportable fire needs some alteration. On the other hand, some may feel that another public agency is not needed, that the money is wasted, that the ranger is encroaching on the authority of the local fire department, or that the local people can handle any and all fires without outside help. Such people will not be very cooperative.

These and other examples were challenges to the ranger in district #11 in selling his program. However, he has been successful in making friends and furthering fire prevention and prompt reporting of fires.

This has been accomplished in such ways as showing movies and speaking to schools and adult groups, personal contacts, cooperating with rural fire departments and other public agencies, displaying efficient know-how in fire fighting, and having an adequate law enforcement program.

District #11 rangers have attended meetings ranging from the Ladies Aid Society to Feeder Pig Associations. They have made calls at school forests, summer camps, fairs, firemen's meetings, fire fighting demonstrations, parades, and conventions. With a movie projector, a Smokey Bear suit, or just an informal talk, they have managed to get their message across.

The annual fire reports indicate that public detection and reporting of forest fires in Wisconsin's district #11 is a success with gains each year:

		Fires reported by the public	
Year:	Total Fires	*Number*	*Percent*
1955	234	137	58
1956	248	158	63
1957	227	144	63
1958	377	254	67

FIRE PREVENTION POSTER PLANNING

L. K. Kelley
Staff Assistant, White Mountain National Forest

Fire prevention is necessarily a long-range program since the habits of people are slow to change. Repetition of the prevention message is, therefore, a basic policy of this program. Once the causes of fires have been determined, there are several effective media that may be used to spread the message of fire prevention to large numbers of people. One of these media is the poster. Some posters motivate people by appealing to civic responsibility; others appeal to sentiment (fig. 1), or to self-interest. Some are of the regulatory type, such as the closure poster (fig. 2), that is intended to restrict the movement of forest users and calls attention to the penalties for violation.

An effective poster appeals to different people in different ways. A poster emphasizing financial losses due to forest fires may appeal to self-interest or to civic responsibility. One depicting the plight of wildlife will appeal to sentiment; to hunters, the appeal may be to self-interest. Such posters as "Keep America Green" appeal to both sentiment and civic responsibility.

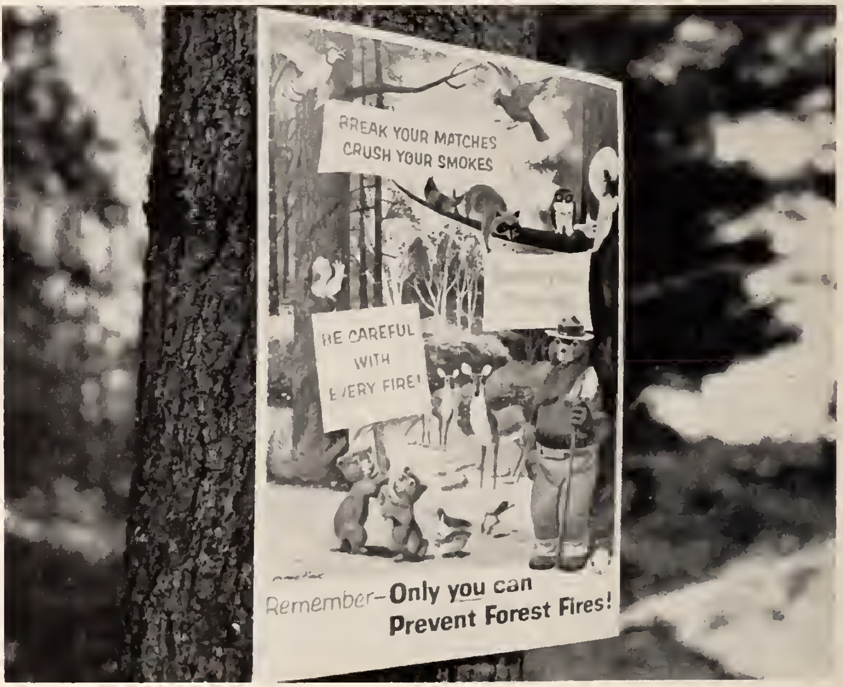

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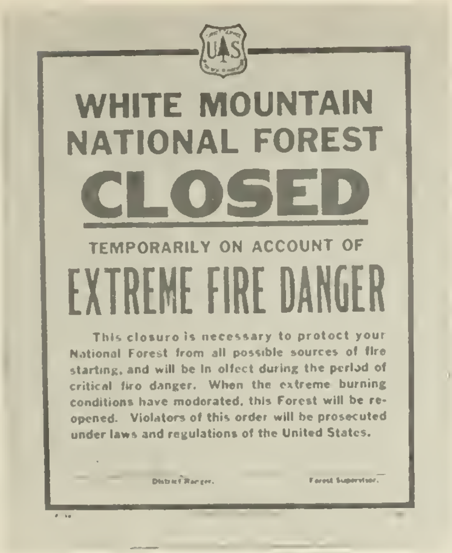
Figure 1.—Posters appealing primarily to sentiment often carry a symbol of fire prevention such as Smokey Bear.



WHITE MOUNTAIN
NATIONAL FOREST
CLOSED
TEMPORARILY ON ACCOUNT OF
EXTREME FIRE DANGER

This closure is necessary to protect your National Forest from all possible sources of fire starting, and will be in effect during the period of critical fire danger. When the extreme burning conditions have moderated, this Forest will be reopened. Violators of this order will be prosecuted under laws and regulations of the United States.

District Ranger. Forest Supervisor.

F-493435

FIGURE 2.—Closure poster prohibits entry.

Posters must be attention getters. They should carry a timely message with enough variation to keep them interesting, and be designed for seasonal and functional use to reach the individuals for whom they are intended. A well-developed prevention poster plan will obtain adequate coverage and avoid overposting. Many factors must be considered in developing the plan; these vary with the risk involved.

Types of posters.—Generally, the many types of posters now in use are attractive, eye-catching, and brief. The sizes vary with the particular needs. Large posters should be displayed on high-speed roads (fig. 3), with smaller sizes used on trails and back-country roads. Other types of posters and signs may carry an "injected" fire prevention message. An information sign implying the fire prevention message is shown in figure 4.

Intensity of posting.—The frequency of posting will vary with the scope of the program, type of use, and rate and pattern of travel. Using too few rather than too many is a good general rule, since the least number that will do the job will be the most effective. One frequently used guide is to display large posters at 5-mile intervals on highways, and smaller posters at 2-mile intervals on horse and foot trails. Functional posters (fig. 5) are displayed, as needed, at hunting and fishing campsites, logging areas, and organization camps.

Location of posters.—Public reaction should be kept in mind when selecting poster locations. Create pleasing displays by using attractive backgrounds. Make sure that posters do not interfere with scenery, recreation areas, or information signs. Limit highway posting to the use of permanent posters at points where traffic normally slows down. Avoid posting that interferes with the motorist's vision and thereby creates traffic hazards.

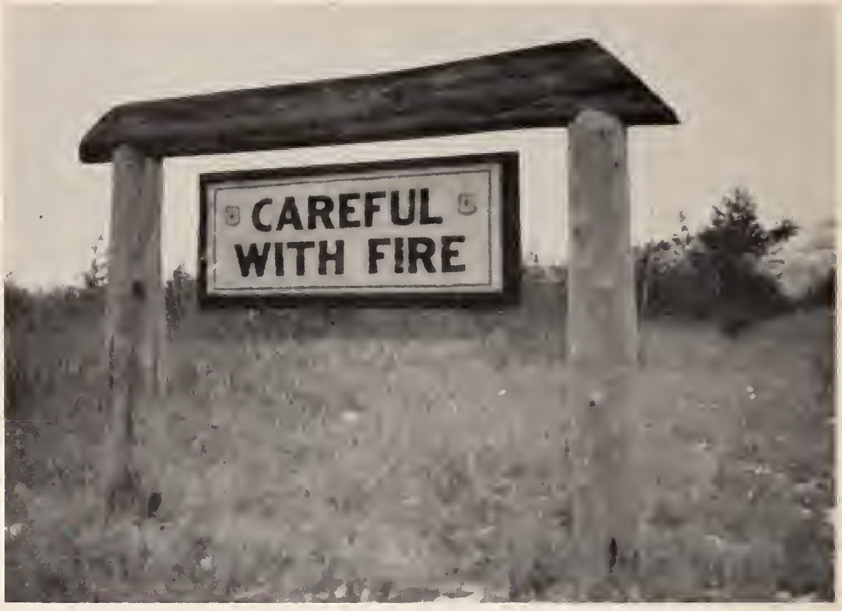


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Figure 3.—A prominent poster with a brief message and large lettering suitable for high-speed roads.

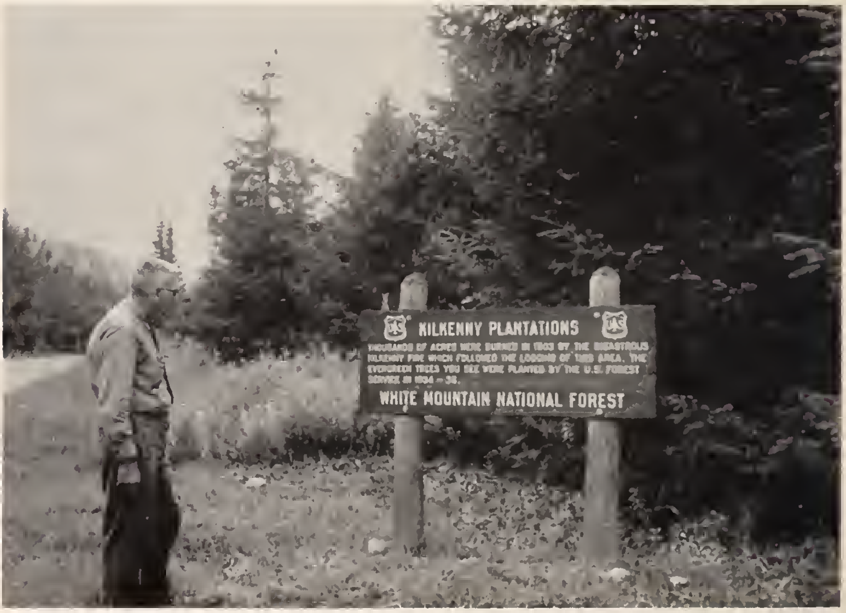

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Figure 4.—A plantation sign with an implied fire prevention message.

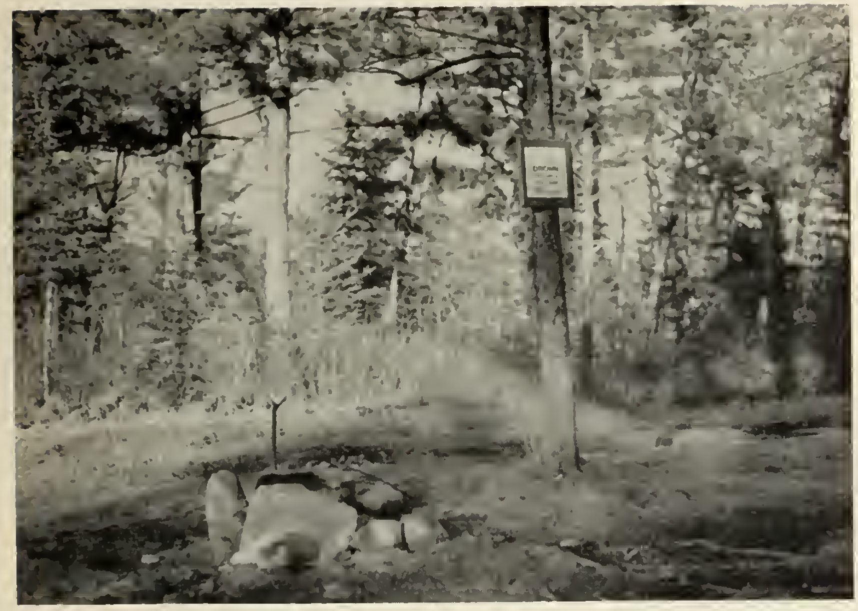

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FIGURE 5.—A functional poster at an undeveloped campsite.

Maintenance.—Maintenance is a most important item. Poorly installed or poorly maintained poster displays may be detrimental to the entire prevention program. Unsightly posters are a liability and must be replaced at once. Also, change posters as seasons and risks change and remove them when the risk no longer exists.

A poster worth displaying is worth putting on a backboard unless the poster is for temporary use. Wherever placed, it should carry the prevention message to the public.

SUMMARY

Posters can be effective fire prevention tools. To be effective, however, their use must be carefully planned and controlled. The plan should:

1. Show poster locations.
2. State uses of posters.
3. Note type of message to be used at different times of the year.
4. Show number of posters currently installed.
5. Show tentative maintenance schedule.
6. Include placing and destroying of temporary posters.
7. Control poster installations by others; e. g., cooperating agencies and private organizations.
8. Provide for periodic plan revisions.

SLASH DISPOSAL IN FIRE PLANNING

S. T. MOORE
Chief, Branch of Information and Fire Control,
Rocky Mountain Region, U. S. Forest Service

One of the important responsibilities of a forest resource manager is the formulation and execution of fire protection plans for his unit. In making these plans he must analyze the fire hazards existing on the unit and the risks to which the forest is exposed. One basic decision that must be made is the amount of burned acreage that can be tolerated in any period without jeopardizing management objectives. A fire control organization must then be planned which is adequate to hold fire losses within prescribed limits during worst probable fire weather and risk at the least possible cost.

On a national forest the basic fire planning unit is the ranger district. All district plans on a national forest are coordinated in a forestwide plan.

In planning an adequate fire control organization the resource manager should utilize all facilities at his disposal, integrating them into a coordinated plan for the unit. This plan will include a basic fire control organization concerned with prevention, detection, and initial attack. It should also include provision for use of other personnel and facilities as fire danger rises and as high risks occur. Additional manning will include all facilities available to the local unit; other district crews of all types—road, improvement, survey, timber management; logging and sawmill operators; construction contractors; and other industrial operators and forest users.

Important components of Forest Service fire protection strength in the West are the crews and individuals whose primary duty is disposal and protection of logging slash created as the result of national-forest timber sales.

Timber harvesting operations, because of hazard involved, have a tremendous impact on the fire planning job. When planning, it is imperative that consideration be given to the effect of slash hazard on the entire protection picture.

Essential steps in planning and carrying out an adequate slash disposal and protection program are as follows: (1) Determine the size of the job; (2) decide what facilities are needed to do the job; (3) estimate the cost of the program; (4) provide for necessary finances, personnel, equipment, facilities, and training; (5) dispose of slash or provide additional protection for a specific period.

The size of the job will be determined by the area of slash created each year, the density of slash per acre, the fire weather that can be expected, the risk to which the area will be subjected, topographic considerations, accessibility, the degree of disposal needed, forecasted increase or decrease in rate of cutting, and amount of slash to be given protection in lieu of disposal.

The next logical step in planning the slash disposal job is to determine the facilities needed, such as manpower, supervision, housing, lookout structures, transportation, and equipment (tankers, pumps, hose, torches, radios, handtools). It is essential that adequate inventory be made of facilities already on hand which would be available for the job. From this inventory plans can then be made for additional facilities required.

Cost estimates for disposal by burning will vary among areas. The timber sale area itself will be the planning unit. For additional protection the planning unit may be a watershed, a ranger district, or a larger area. The remaining part of the job is to recruit, organize, equip, and train needed manpower to accomplish the actual slash disposal or extra protection work.

The slash disposal and slash protection organization is an important part of fire protection. Although its primary purpose is for work on timber sale areas, it furnishes a supply of immediately available manpower trained and equipped for fire control. When properly coordinated in ranger district and national-forest manning plans, this organization greatly strengthens the regular fire protection force.

Another way in which slash disposal can be coordinated with regular fire planning is in the execution of the slash burning job. Where this job is heavy and the number of days throughout the year when effective burning can be safely done is limited, it becomes imperative to utilize all possible facilities and manpower during the burning season. Regular fire protection personnel are trained and experienced in fire behavior and fire suppression work and lend efficient assistance in the slash burning job. Burning is usually done when these men can be spared from their regular fire protection duties. They form a logical and effective supplement to the regular slash disposal crews.

So important to the entire fire protection job is the current disposal of slash that plans should be made to utilize all available sources of manpower, supervision, and equipment. In addition to the regular fire force already mentioned this should include all available personnel, regardless of regular assignment.

It is often necessary during the actual burning period to man one or more regular protection stations, including lookouts. This is important for several reasons: To furnish minimum fire control coverage for the rest of the district; serve as a communication hub; record fire weather observations on areas that have been burned and not yet mopped up; warn of sudden change in fire weather.

There is another important reason for including all personnel in plans for slash burning. On many districts, several years may elapse before a large fire occurs. Where slash disposal is an annual job, it furnishes a good opportunity for actual experience and training in fire behavior and suppression.

Where timber being harvested creates slash hazard, adequate plans must be made for current abatement and protection of slash. An important responsibility of the land manager is planning, financing, and carrying out this program. The most effective use of money and manpower is made when the entire slash disposal and protection program is integrated in the overall fire plans for the basic planning unit. This results in the best possible total fire protection organization at the least possible cost.

FIRE PLANNING FOR THE WASATCH FRONT IN UTAH

ELMER M. BACON
Chief, Division of Fire Control and State & Private Forestry
Intermountain Region, U. S. Forest Service

The critical watersheds of the Wasatch Front are in ever-increasing jeopardy from the loss of vegetative cover due to fires. Historical records and recent disastrous floods and mud flows into adjacent Utah communities attest to the damage potential inherent in any fire on these watersheds.

The Wasatch Front area, located in northern Utah, is approximately 100 miles long and 30 miles wide (fig. 1). It extends from a point north of Brigham City south along the precipitous range behind Ogden, Salt Lake City, and Provo (fig. 2) to a point near Spanish Fork. Three-fourths of the population of Utah live adjacent to this mountain front. They depend on it for water, and much of their outdoor recreation; and their homes and even their lives depend on its slope stability.

The job of the fire planner for the Front area is complicated by two factors. First, there is a population and suburban expansion onto the lower slopes of the mountain range with attendant risks and increased man-caused fire incidence. Second, there is the extreme hazard and rapid rate of spread characteristic of the flashy cheatgrass and oak brush fuels that clothe the slopes, extending from valley floor to mountain top in many places. The elevation ranges from 4,000 to 10,000 feet.

Added to the problem of planning for adequate suppression is the fact that fire-weather conditions are typically critical during July and August. The precipitous west slopes are directly exposed to drying desert winds that often have velocities of 40 m.p.h. during this period.

The land ownership pattern, especially on the lower slopes, involves several agencies in the fire protection effort. National forest, State, county, city-owned watershed, and private lands intermingle in many places and are interdependent for fire prevention and suppression. Close cooperative working relationships have been developed to meet recognized fire responsibilities. The effectiveness of this team approach affords an outstanding example of the cooperation that is possible among different levels of government in the protection of critical watersheds.

In current planning several criteria and objectives have been established:

1. The Wasatch Range has been placed in the highest wild land value classification in recognition of watershed values and direct valley-mountain relationships.
2. Analysis of fire damage on these watersheds has provided a sound basis for establishing maximum fire limits. These

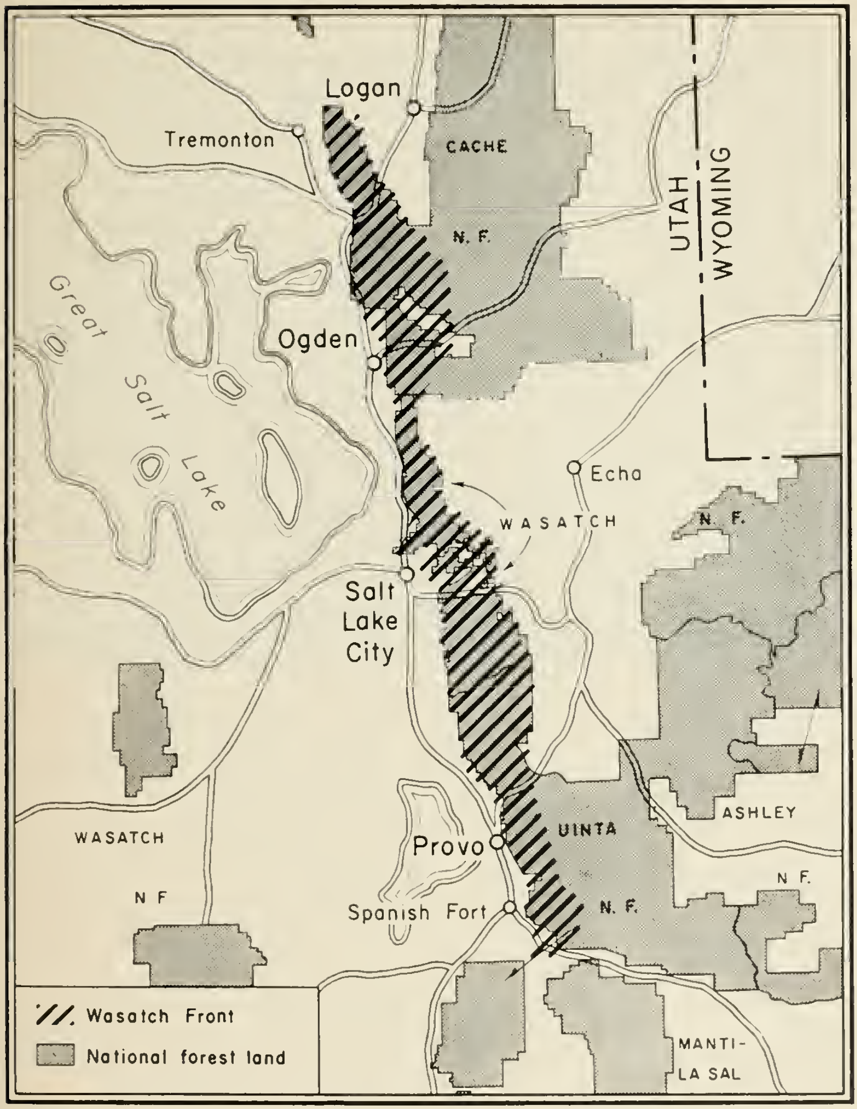

Figure 1.—The Wasatch Front in northern Utah.

are in line with national Forest Service standards. For this area, a 10-acre limit for any fire has been established (with provision for a 20-acre limit in flash fuels, except for drainages immediately tributary to municipalities).

3. Data covering fire's rate of spread, resistance to control in fuel types, and weather conditions (represented by a fire danger rating of 70 on the Intermountain Forest and Range Experiment Station meter) were used to set hour control standards needed to meet size-of-fire objectives.

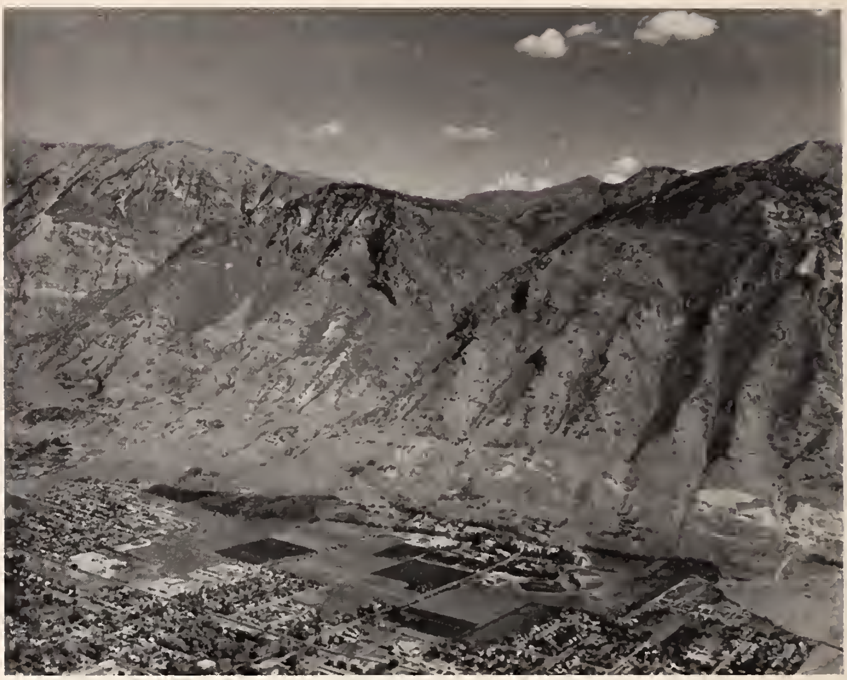

FIGURE 2.—The Wasatch Front at Provo, Utah.

Planning must be directed to two major necessities if fire control objectives are to be met. The first of these is to strengthen prevention to reduce man-caused fire incidence. To do this, a prevention analysis is underway to develop an action program for specific situations. With the sorting out of problems will come agreement among responsible agencies for assigned segments and the provision of adequate manpower to meet the calculated need. Public support, already strong, can be depended upon to further this effort.

The second major need is to plan for speed and dependability of detection and initial attack in meeting the rapid rate of fire spread in flash fuels. Strength of forces available, however, do not compare with those found on some other watersheds; southern California, for example.

In past years dependence has been placed on public detection. The effectiveness of this indicates the deep local interest in the protection of mountain watersheds. However, the values at stake make it necessary to establish more positive and prompt detection. Analysis has shown that we must have detection within 3 minutes to meet control objectives. Specific locations for detection points are still in the planning stage.

Along with rapid detection must come speed of report and initial attack. This will be provided by FM radio communication, part of which is already established.

Studies of techniques, equipment, and manpower that will most effectively and economically provide initial attack to meet hour control objectives will include air tankers, helicopter delivery of personnel, and direct attack. These new methods will be coordinated with the more common ground attack methods, although in many cases the latter will constitute reinforcement strength. The plan for coordinated attack provides for a driveable firebreak along the lower slope above suburban developments (in addition to the sections already constructed), a system of helispots at selected points to provide hour control coverage for 85 percent of the area, other key secondary firebreaks, and water supply points. A primary air tanker base and heliport are planned at Salt Lake City. Secondary heliports will be provided near Provo, Ogden, and Brigham City. Secondary air tanker bases planned at Provo and Ogden will be primarily reinforcement bases since initial attack, standby air tankers are not planned at these locations.

Conventional ground attack forces will be equipped with tankers and FM radio communications and will be stationed near fire concentrations. An air-ground radio net is also planned to insure coordination of initial attack between air and ground forces.

Planning the Location, Size, and Type of Fire Caches

"Fire planning" is a term long associated with fire control activities. To most people, it means planning the number and location of fire control personnel. In actual practice, however, it must go much further than this. True, manpower is the means for obtaining adequate fire protection. But that, however, requires that men be provided with the necessary firefighting equipment. It is therefore essential that fire caches be included as an integral part of fire planning.

The objective in fire cache planning should be to provide the equipment necessary to meet maximum fire control needs. This involves location and size of caches and type of tools and equipment in them.

Fire caches must be planned to meet the needs of three different forces involved in fire suppression: first, the initial attack crews; second, local reinforcements; and third, reinforcements other than local. Each force presents separate and distinct problems.

Initial attack.—Location and size of fire caches for this type of action should be based on the number of personnel and attack locations established in the local unit fire plan. Each of the initial attack personnel must be equipped with suitable firefighting equipment. Normally, the equipment is composed principally of handtools. However, fuels and topography occasionally dictate the need for mechanized equipment such as power saws and trenchers. The size, location, and type of fire cache equipment needed by such crews cannot be planned until the final organization is determined.

Reinforcement action.—History shows that some fires go beyond the initial attack stage. This is where reinforcement action enters the picture. In some cases, reinforcement action may be only a dozen or so men. In others, it may be several hundred. Some of this personnel is located on the ranger district and forest. Often, however, a portion of the reinforcement action must come from some distance. To supply these reinforcements, it is essential that fire caches be properly located and that they contain the proper amount and type of firefighting equipment.

One method of determining fire cache requirements for this type of action is to analyze fire records. The analysis should be based on equipment and supply requirements over a period of years, expressed in terms of number of men to be supplied. A 20-year period is normally an adequate base for determining equipment needs. The volume of use in this study will establish standard firefighting equipment needs and also serve as an indicator for miscellaneous equipment (except certain special items) and for initial, prepackaged food supplies. Such items, for example, as extra sleeping bags, hard hats, torches, and boxed rations are normally maintained in quantities based on the amount of standard firefighting equipment needed.

Fire caches planned for reinforcement use must be so distributed that they will provide maximum efficiency and speed of supply. The objective should be to stock enough equipment on local units to supply manpower locally available. The balance should be located in central fire caches. Fire planning will determine the amount of local manpower available for fire suppression.—MERRILL E. TESTER, *Forester, Division of Fire Control, Northern Region, U.S. Forest Service.*

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Fire Control Planning in the Alaska Region

Contrary to the common belief, there is an important fire control planning job in Alaska's national forests. Although annual rainfall varies from 26 to 186 inches, with most of the area getting well over 75 inches, we do have periods of high fire danger. The very nature of the timber types and topography in Coastal Alaska lends itself to high fire danger whenever there is a lack of rainfall.

For many years the Alaska region was in a custodial status. There was some timber cutting and other uses of the national forests; however, this use was limited and as a result only a few fires occurred. Harvesting of the timber resource during the past 10 years has materially increased and many thousands of acres of slash are created each year. Also more people are using the national forests and as a result, more fires are started. Then too, there are examples throughout Southeast Alaska of fires having occurred in undisturbed stands.

Because of the vast, relatively unpopulated nature of the national-forest areas and the lack of a systematic detection system, it is often several hours before a crew can be placed on a fire. There is a real job of planning in order to detect fires in their early stages and get someone on them before they are out of hand. Two large fires in the past 2 years show that given the right conditions, we can have serious fires with much damage.

There are an average of 39 days during the summer season when fires will burn. These days occur over a 3-month period beginning in June. If as many as 8 or 10 of these fire-weather days are consecutive, we have potentially dangerous conditions. The 20 to 22 hours of daylight speed up the fuel drying process. As soon as rain stops falling, the moss begins to dry out; then the fine litter. Slash areas soon reach an explosive condition and because of the rugged topography a fire starting at the bottom of a draw in a cutover area quickly sweeps to the top. Much of the soil is shallow, of organic origin, and underlaid by bedrock. Fires burning over this type of soil during dry periods destroy much of the soil itself, leaving scars that will show for many years to come.

Because of this increasingly important fire problem, we must develop a fire danger rating system that will warn of an impending hazardous fire situation. The development of a fire danger meter or rating system indicating such a buildup will enable us to take the necessary precautionary action with loggers and the general public and thus prevent the occurrence of large fires. We are only in the early stages of a comprehensive fire control planning program.

Fire occurrence is relatively low and practically all fires are man-caused, lightning having caused only three fires during the past 10 years. The Alaska Region lacks many of the facilities found in other Forest Service regions. All forests are practically roadless and trails are few and far between. Airplane landing strips are nonexistent. With the present pattern of fire occurrence and high hazard and risk areas so widely scattered, a detection system as commonly used is not practical. Communication is mostly by radio and does not adequately meet the demands of general administration and fire control needs. Because of these conditions planning for prevention, detection and suppression poses problems not found elsewhere.—WAYNE SWORD, *Chief, Section of Operation and Fire Control, Alaska Region, U. S. Forest Service.*

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Planning Initial Attack With Water

On the Quinault Ranger District of the Olympic National Forest, three 1-ton trucks with standard Forest Service 160-gallon slipon tanks were used in planning initial attack on small fires with water. Each unit maintained the following equipment:

1. Portable pumper.
2. Live reel.
3. Nozzle kit.
4. 500 feet of 1-inch C.J.R.L. hose.
5. Fire tools for five men.
6. A 30-watt two-way mobile radio.

Each tanker was manned by a leader and two men well trained in the use of the equipment.

During periods of fire danger, each of the three crews worked within hearing of its radio which was kept on continuous standby. Work was planned so that the crews were more or less evenly spaced over the district and any fire occurring would be within easy reach of one crew.

To have everything in readiness, each morning the crews started the pumps, ran them up to regular operating pressure, checked for adequate gas and oil, and made sure the slipon tank was fully loaded with water. No crew was allowed to leave the station unless the equipment operated perfectly. The crew leader immediately reported any mechanical trouble to the fire dispatcher and arrangements were made to make repairs or replacements.

A spare pump was always ready at district headquarters to replace one that failed. Spare nozzles, hose, and other equipment that might be needed were also kept on hand.

Crews attended preseason guard-training camp and in addition were given at least 24 hours' training in the use of water for initial attack. During the summer, crew leaders were encouraged to hold frequent practice sessions in the use of their equipment.

At the first report of a fire, the closest crew was dispatched and the other two crews instructed to move to the fire. The first crew to reach the fire was instructed to use water on the hot spots and attempt to stop the spread. If help was needed, the plan called for the second unit to move in at about the time the first unit ran out of water. The third unit, if needed, would arrive in time to relieve the second unit. When a unit expended its water, it was to go to the nearest source for another load, leaving one crew member to fight the fire with handtools. If one man could load the tank from the nearest source, two men would stay with the fire.

As one of their regular jobs, crews developed and maintained all available water sources along roads in their work area. This gave them firsthand knowledge of each source. Water tanks were set up on ridgetop roads when other sources of water were not available.

This system was used successfully on several fires. On those fires where hose lays longer than 500 feet were required, initial attack with water became ineffective; the crew then resorted to handtools and reinforcements were ordered.

With ranger headquarters located geographically close to the center of the district, two work centers were established—one in the south portion and one in the north. It takes about 1 hour to travel from one end of the district to the other. The work centers spaced the crews so that first followup could arrive at a fire within approximately 30 minutes maximum elapsed time. By carefully conserving water, a crew could carry on the attack until the next crew arrived.—CLARENCE E. EDGINGTON, *Regional Fire Dispatcher, Pacific Northwest Region, U. S. Forest Service.*

INFORMATION FOR CONTRIBUTORS

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FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 21 **Number 1**

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (October 17, 1958).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1960

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CALIFORNIA HELITACK REPORT—1958

JAMES L. MURPHY[1]
Pacific Southwest Forest and Range Experiment Station

Many questions about Helitack required answering at the beginning of the 1958 fire season. This was the 12th year helicopters had been used in fire control in California. It was the third year of the Helitack Project, the cooperative research and development program aimed at integrating the helicopter into fire control.[2] Helicopter accessories such as the hose dispensing tray and the 40-gallon helitank had been developed through Helitack. Over 400 forest firemen had been trained in "Helitactics" throughout the State. What were the results of this intensive program to be? Would unforeseen problems render many of the techniques impractical? And what about large helicopters—would they soon replace the small ones? To determine some of the answers to these questions, evaluation report forms were distributed to all units using helicopters throughout California.

During 1958, nine national forests in California had helicopters on permanent standby at a base heliport within the forest. Six additional forests had agreements with helicopter contractors who guaranteed helicopter service when ordered. The remaining two forests were able to order helicopters for fire projects when needed by requesting them through their zone dispatcher.

California State Division of Forestry districts had "on call" agreements with several helicopter contractors, sharing the service of a helicopter with adjacent national forests in several cases. The Los Angeles County Fire Department owned and operated three Bell G-2 helicopters out of their base heliport in Los Angeles.

Fire control projects constituted the majority of helicopter use in California during 1958. During periods of low fire danger, the helicopter was used for various nonfire projects, such as manning and supplying lookouts, road location, telephone pole setting, timber cruising, and game surveys.

"HELITACK" USE ON FOREST FIRES

Helicopters were used on a reported 60 forest fires in California in 1958. They were used for many of the same types of jobs they performed 10 years before, but many more jobs were new ones.

Helitack crews.—Helitack crews made initial attack on a reported 32 fires throughout the State. The crews made helijumps on 15 of the fires. The helicopter was able to land on the other 17. The crews' average elapsed travel time to these fires was 35 minutes. Ground crew travel time to the same fires averaged 5 hours and 42 minutes.

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[1] This report was prepared under terms of a cooperative student-aid agreement between Utah State University and the Experiment Station.

[2] Helitack: A cooperative program between the U. S. Forest Service, the U. S. Army, and the California State Division of Forestry.

The crews performed specialized jobs on large fires. They functioned as base heliport managers on 21 large fires, loading and unloading personnel and cargo and managing the installation and use of helicopter accessories. Helitack crews constructed 19 helispots on 15 fires to ferry large crews to remote sectors of the fireline. On the majority of these fires, the crews had to helijump to the ground to construct the helispots. On seven large fires, helicopters and Helitack crews made initial attack on slopovers, blowups, and spots in areas where immediate action was necessary and ground crews were not available.

Reconnaissance.—A total of 575 reconnaissance missions were made on the reported fires in 1958. The old argument of fixed-wing aircraft versus helicopter for reconnaissance was renewed by many units who reported that the slow flying speed of the helicopter, coupled with its maneuverability and ability to fly close to the ground make it possible to make detailed observations whose value could not be matched from fixed-wing aircraft.

Helicopters helped to locate seven fires in areas unseen by fixed lookouts and guided the ground crews to the fire area.

Law enforcement was handled by helicopter reconnaissance personnel on two fires when a suspected firebug was spotted, chased, and the car license reported to apprehending police on the ground.

The helicopter functioned as a "bird dog" ship on seven fires, leading retardant-carrying air tankers to the fire and directing the drops.

Ferry missions.—Helicopters ferried 1,616 firemen and 53,112 pounds of cargo on the 60 fires reported. Helispots constructed by Helitack crews made it possible to place many of these men in remote areas which would take hours of hiking time to reach. Use of the electrically released bomb shackle assembly[3] allowed more cargo to be carried in a safer manner than previously used methods. Much of the cargo was dropped by parachute using the new paracargo rig developed by the Arcadia Equipment Development Center.

Helitank drops.—Foresters reported that 186 water and retardant drops were made by helicopters during the season. They also reported that over 75 percent of the drops made with the 40-gallon helitank were instrumental in retarding or suppressing spot fires and flareups in areas where ground crews and air tankers were not available. On three fires on the Angeles National Forest, helitanks were credited with being the most important factor in suppressing spot fires which threatened the loss of critical portions of the firelines.

Hoselays.—More than 15,000 feet of fire hose were laid by helicopter on wildfires in 1958. Probably the longest helicopter hoselay yet completed on a forest fire in the United States was made on the Monrovia fire by the combined Helitack crews of the Angeles Forest and the Los Angeles County Fire Department. Ten thousand feet of 1½-inch hose was laid in 20 consecutive trips over rugged terrain to aid control of one critical sector of the fire.

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[3] Arcadia Equipment Development Center. *Fire Accessories for the Light Helicopter.* Fire Control Notes 19:82-87, illus. 1958.

Other fire jobs.—Injured firemen were evacuated from remote fire areas by helicopters on two fires and backfiring operations were carried out by dropping lighted fusees from the helicopter on several others.

TRENDS IN HELITACK

Helitack reinforcement crews.—Although the Helitack crew functioned during large fires and on fire concentrations, such as "lightning busts," they could not handle the entire Helitack operation. To maintain the flexibility of the operation, ground crews were trained in helitactics, including safety, and were called on to function as reinforcement crews when necessary. These trained reinforcement crews were extremely valuable on large fires when the regular Helitack crew was engaged in performing specialized jobs on the fireline. They acted principally as service crews, managing helicopter operations at the base heliports.

Integration of conventional ground crews into the Helitack operation was the result of another important fact demonstrated during the 1958 fire season: Helitack cannot replace the ground fire suppression organization. On several fires high winds in the early stages made air attack impossible. The ground crews had to do the job; Helitack, then had to be an additional tool, a supplement to the existing organization.

Cooperation between agencies.—One of the highlights of the 1958 fire season was the close cooperation between the air units of the various fire agencies. On one project fire a Forest Service Helitack crew combined operations with the Los Angeles County helicopter unit to control a critical portion of the fire. The Helitack crew jumped to a potential helispot location in a remote area and constructed a helispot. The fire spread was slowed by nearly 40 helitank drops of water until the helicopters could ferry in a 25-man crew to construct the fire control line. The entire operation was completed in less than an hour.

Top pilots emerge.—One significant factor was obvious in 1958: The outstanding pilots were those who had returned to the same forest for the second or third year. The pilot's knowledge of the country and its flying conditions and his experience on fires proved to be invaluable in the efficiency and safety of the operation.

Air control problems.—Nearly every unit reporting declared air control a major problem. Project fires, on which several helicopters were operating along with air tankers and other fixed-wing aircraft, presented the biggest control problem. Most units declared dependable radio communications on all aircraft to be the only good answer. Others stated that radio congestion on ground frequencies made a separate air net vitally necessary.

To reduce radio congestion, one Helitack crew used preorganized initial attack plans, each plan designated by a letter. Plan A was a 100 percent jump operation; Plan B, jump and Helitank drop alternated, etc. By radioing the plan letter and fire location back to the base heliport, the operation could be carried out with a minimum of radio traffic.

New helicopters.—A new helicopter, the French "Allouette," joined the Bells and Hillers that have been used for several years. Only one Allouette was available in California in 1958, but it demonstrated its ability to out-perform other ships, especially in transporting bigger payloads in less time and at higher operating density altitudes.

The Klamath National Forest credited the Allouette with playing a leading role in helping to avert what otherwise could have been a major conflagration. Eight men were transported in two quick trips to an isolated fire at an elevation of over 6 thousand feet. With the additional help of an air tanker drop these eight men were barely able to contain a fast spreading fire. Fewer men delivered over a longer period of time by a less capable helicopter would not have done the job.

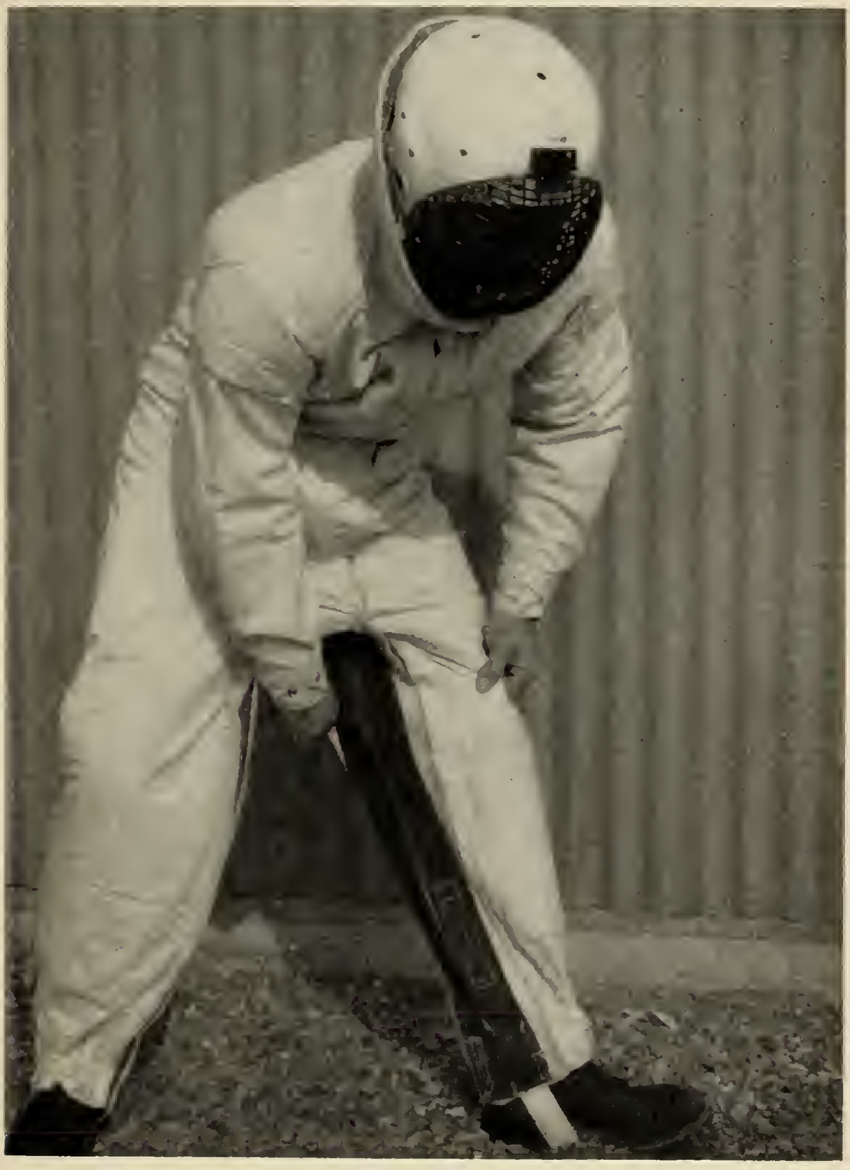
WHAT ABOUT LARGE HELICOPTERS?

Because of commercial availability, only small helicopters were used in Helitack operations in California in 1958. However, to plan for the future, each helicopter evaluation form included the question, "Would a large helicopter have been more effective?" Thirty-two answers were received, 26 of them stating the opinion that the large helicopter would not have been more effective. The reasons almost unanimously given were (1) limited landing area made it impossible for the large helicopter to land anywhere near the project; (2) high elevations and turbulent conditions made it unsafe to attempt large helicopter operation. Several forests reported that the small helicopter was able to transport enough men to do the job and that a larger helicopter would not have been necessary.

The six affirmative reports thought that larger helicopters could have delivered "more men" or "more retardant" over a given unit of time and would have been desirable.

Helijumper Protective Suit

A helijumper protective suit has been developed by the Missoula Equipment Development Center. It is designed to protect firefighters from brush, trees, rocks, etc., when jumping from helicopters at a height of about 6 feet. The suit is covered by U. S. Forest Service Specification 5100-176. Specifications and price information are obtainable from the U. S. Forest Service, Federal Building, Missoula, Mont.—ARTHUR W. JENSEN, *Forester, Division of Fire Control, U. S. Forest Service.*



DO SMOKERS REALLY CAUSE ALL SMOKER FIRES?

E. S. Bliss
Forester, Region 3, U. S. Forest Service

In the Southwestern Region of the Forest Service, which includes Arizona, New Mexico, and western Texas and Oklahoma, smokers and smoking are cataloged as causing the largest number of man-caused fires. About 140 fires on the average are listed each year as smoker fires. This is roughly 45 percent of all man-caused fires. Detailed information in most fire reports on smoker fires lists cigarette butts as the proximate cause. Most foresters think the discarded, burning cigarette is the villain too many times when it is often an accomplice. The smoker category has become a "catch all" for fires of uncertain origin.

Efforts at fire prevention are falling short of the results that we should obtain because we are overlooking other causative agents perhaps more potent than the ever-present butt, and possibly even greater than the smoker.

It is common knowledge that cigarette and cigar butts start fires only under limited conditions. A large number of tests have been made in a casual way, but they all lead to the same conclusions:

1. A burning cigarette or cigar butt in contact with rotten wood or dry duff will often ignite them especially if there is a breeze.

2. A burning cigarette in dense, dry grass at the base of a grass clump may, if there is a breeze, cause ignition but only if the grass is very dry and slightly decomposed.

If the cigarette and cigar butts are not the villains in the fire drama that they are thought to be, then who are the other rascals? Who except smokers are starting smoker fires? What causes all of our smoker fires? Here are some causes seldom listed.

Matches.—People who have learned to break their matches sometimes get their finger burned. In bright sunlight the flame on a burning match is difficult to see, and if the match stem and the air are dry, difficult to blow out. Many people over forty-five and without their glasses see a match at arm's length only as a blur. Just because the paper safety match appears so innocent, it is especially dangerous. Few people break them as they do wooden matches.

Besides lighting tobacco, people do many other things with matches. If a person suspected of starting a fire does not smoke, he should not for that reason be ruled out; he may have struck a match for some other purpose. People strike matches for light to look under car seats, into batteries and radiators, (and occasionally gas tanks), at oil measuring rods, and to ignite tire repair patches. They light matches to sterilize pins, needles, and knife blades. They light matches to burn insects and seeds stuck to their clothing. They light matches to sear and stiffen the ends of thongs and laces. They strike matches for children to blow out. These are but a few of the common uses of matches not often considered.

We need a campaign to reduce careless use of matches. The old slogan "Break your match before throwing it away" is good but better is "Break your match then spit on it" or "Put your match in your ashtray or tramp into bare earth." A large number of grass fires and fires that start in light fuels could be prevented by extinguishing matches.

Lighters.—There are many kinds and makes of lighters—some good and some bad. The good ones appear to be safer in the woods than matches. Some of the bad ones spray or drip flaming fuel like a drip torch. These may be overcharged or leaky. Their use in the forest is about as dangerous as the use of a torch would be. City fire department officers confirm our view that some lighters are very dangerous.

A study is needed of lighters and their uses. If the dangerous ones are of a certain brand, this could be corrected by legal action if more expedient methods failed.

The Curious Incendiary.—Some fires are started by people who are curious to "see if it will burn." Not all are children, and the number is greater than we suspect. Some of these fires get into the smoker category because investigators are hesitant to believe that full-grown men and women will start fires for no apparent reason except to find out whether a clump of grass or pile of leaves will burn. Psychologists call it compulsion among other names. Probably most of us have felt the urge at one time or another. We should recognize that it is not an uncommon trait in the human race.

There is not much that we can do about our "fire bugs" except to learn who they are and put them out of harm's way whenever possible and for as long as possible.

There are many other causes of fires that sometimes are classified as smoker fires. They include backfiring of automobiles, shooting tracer bullets, homemade rockets, missiles, and fireworks. Only by examining the evidence on each fire critically will we learn more about causes than we know now, and thus be better able to prevent them.

THE CHEROKEE INCIDENT

[Extracted from a report by District Ranger L. C. Nix,
Tellico Ranger District, Cherokee National Forest,
Southern Region.]

The incendiary Tobe Creek fire occurred April 7, 1959, under extreme high fire danger conditions and burned 412 acres before it was controlled at 4:25 a.m. the following day. The incident took place between 10:00 and 10:30 p.m.

Conditions on and adjacent to the fire area required that extreme caution be exercised in planning the attack. The following factors were considered:

1. The area is rugged mountain terrain. Slopes vary from 40 to 75 percent.
2. Burning conditions were critical.
3. This same area burned in 1953. Prior to this, it was heavily stocked with sapling-, pole-, and sawtimber-size yellow pine. Most of the timber was killed and since has fallen. This left the area covered with a thick blanket of pine seedlings, hardwood sprouts, and highly flammable down and dead material.
4. Shifting 15–25 miles per hour winds.
5. Time of day—midafternoon.
6. Weather forecast.

The first set of the Tobe Creek fire was discovered at 2:35 p.m. and the second set at 2:50. At 2:52 Forestry Aid Beecher Colvin and six men were dispatched to the first set. At 3:00 Forestry Aid Onus Thompson and a five-man crew were dispatched to the second set. At 4:00 it was decided that to attempt control as two separate fires was unsafe.

At 5:00 p.m. the air scout reported that the fire looked as if it was going to cross the creek at the southeast corner. At 5:15 White and crew were dispatched from the Six-mile fire to prevent this crossing. Farther west and north spotting was frequent. Wind was now estimated at 25 miles per hour with direction changeable. Backfiring was extremely difficult and had to be done with caution because of the large amount of fuel and the shifting winds.

Shortly after White and crew started building line from the northeast corner, Earl Veal and crew reached the fire and started helping with the line in a southwest direction. As a safety measure White sent crew leader Veal ahead to the junction of the hollows to scout the possibility of the fire crossing over below them. White had previously scouted ahead and found a dropoff with slopes about 75 percent. Before Veal had time to reach the junction, Ranger Nix, who was fire boss and located in Wauchesi lookout tower where he had full view of the fire, noted a small flare up ahead of the fireline. Nix informed and cautioned White and Veal. Shortly, Veal called for help to prevent the fire from crossing the hollow. White sent 5 men with instructions to hurriedly make a preliminary line down the dry branch bed which was more free of debris. In 2 or 3 minutes the spot looked as if about half an acre exploded. Nix again informed and cautioned White and Veal. White started down the hollow to investigate, and met Veal coming up the hollow.

In the meantime, Nix ordered all air communications traffic on the three southend districts clear for Veal and White and safety of the men.

An alternate escape route into a burned area was designated for Veal and the five men. White gave Veal instructions to let him know when the fire crossed the hollow. White ran back up the line to the other men to recheck and review safety route. Within a few minutes, Veal notified White that the fire had crossed the hollow. White divided the men into two groups. As an escape plan, the first group was to go within a burned area above them and the men on the south end to go within a burned area to the south and west of the junction of the hollows.

The wind shifted to east northeast. White spaced the 16 men on this sector about 50 feet apart and backfired the preliminary line. The men were kept as two groups to carry out the safety plan if need should arise. The men held the line which was approximately 6 chains.

Control of the fire without injury or worse was due to—

1. Basic training, and particularly reviews on tragic fires in the West in recent forestwide and district training sessions, in both forest fire safety and suppression.
2. Two-way radios.
3. Ordering the air cleared for safety.
4. Ranger Nix's view of the fire from Wauchesi lookout.
5. Ranger Nix's knowledge as to location of crews.
6. White's experience in fire suppression.
7. White's control of his men. All remained relatively calm.
8. The preliminary fireline.
9. Shifting wind to east northeast.

[Knowledge and application of the Ten Standard Fire Fighting Orders.—Editor.]

HOSE FOLDING JIG

L. F. Deyak

Fire Control Aid, Ely Service Center, Superior National Forest

For efficient laying of folded hose, whether from packsack or pack frame, neat, compact, evenly folded hose is necessary. Past methods of folding produced irregular, loosely packed, costly hose folds which quite often when being strung out became fouled, causing undue delay.

To eliminate these problems a simple hose folding jig has been constructed on which the hose is folded compactly and efficiently. Hose folding time has been cut at least in half.

Base of jig is a frame 42 inches long by 24 inches wide constructed from 1- by 6-inch lumber. Into base are placed ½- by 3-inch hardwood dowels. A piece of ⅜-inch plywood 36 by 24 inches with matching ⅝-inch holes to fit over base and dowels completes the jig (fig. 1).

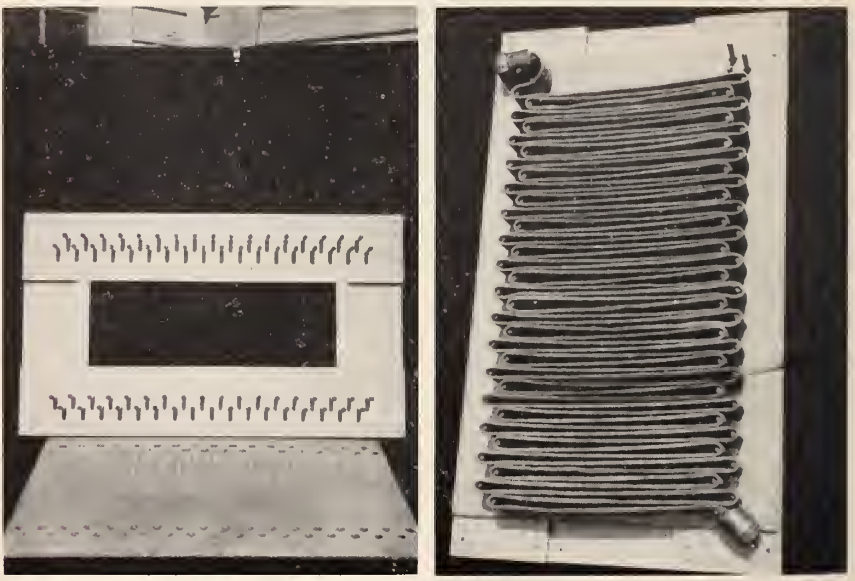


Figure 1.—*Left,* Base with dowels and plywood holder; *right,* folded hose ready for plywood holder to be lifted.

Starting with either male or female end, hose is then folded over and between dowels. Upon completion of fold, plywood board is lifted from base and dowels. Hose can then be slid from board into packsack, tied for storage in fire cache, or held by rubber bands for use on pack frame.

TELEPHONE RECORDER AS A DISPATCHER'S TOOL

Doyle V. Strandlund
Electronic Technician, Kootenai National Forest

A means of recording telephone traffic at the forest dispatcher's desk during project fires to facilitate the logging of traffic and to provide a verbatim record was desired, and the following requirements were established:

1. The recorder must not interfere with normal phone usage.
2. Legal requirements, and telephone company rules, must be met.
3. Both incoming and outgoing conversations must be recorded.
4. The recorder must be simple to operate.
5. A means of indexing the recordings must be available.
6. Recording levels must be maintained as nearly constant as possible with varying line losses.

Various tape, wire, and disk recorders were investigated, but most of these were found to be unsuitable for at least one of these reasons:

1. Poor indexing—desired material could not be quickly found and replayed.
2. Dynamic range too large—if recording volume were turned up for weak voices, strong voices would blast the listener severely, especially with headphones.
3. Costs of extra equipment were considerable.

The Edison Voicewriter with 7-inch disks, used for dictation, was then tried, and it worked very well.

1. Indexing is very good—a calibrated card goes with each disk, on which can be marked pertinent data, such as dates and times, with punchmarks showing stops and starts.
2. The dynamic range is limited making the recorded levels quite constant.
3. The unit is simple to operate.
4. Recording time is limited to 15 minutes for each disk side, but it takes only seconds to change disks.

An adaptor to connect the recorder to the telephone was built (fig. 1). A special plug to fit the recorder must be put together or obtained from a dealer. A transformer is used to isolate the unit from the telephone circuits, and this should have approximately a 600-ohm primary and a 200-ohm secondary. This will bring the telephone line level to about the same as the microphone level, so the recorder may be used on either service without readjustment. A double-pole double-throw toggle switch is used to start and stop the recorder and to disconnect the unit from the telephone. The recorder runs when its switch is in the *open* position, opposite the normal type of switching.

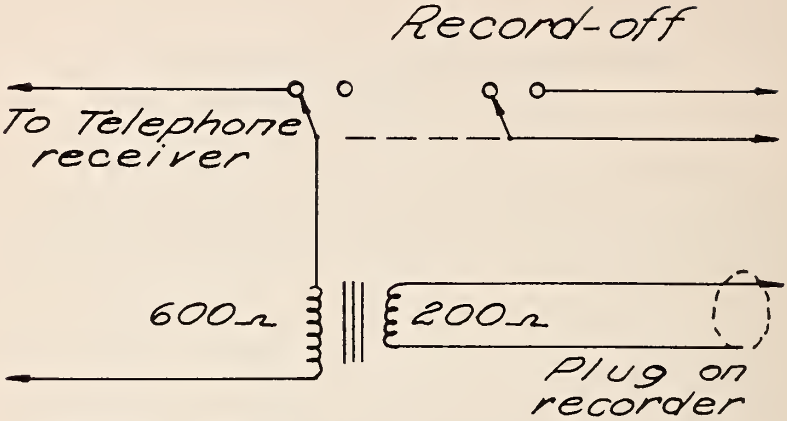


FIGURE 1.—Wiring diagram for telephone recorder adaptor.

To satisfy the legal requirement of telephone recording, the telephone company attached a recorder connecting unit to the telephone. This unit makes the high-pitched "beep" tones that signify recording.

In order to get a more constant level, the local voice should be made weaker when recording, so the distant voice can be amplified. The recorder connecting unit as supplied has no such provision—the output from it to the recorder merely comes from the line. Therefore, with the cooperation of the telephone company, a separate pair of leads was run into the telephone, connecting to the receiver terminals instead of to the line. Because of the antisidetone features of modern common-battery telephones, the local voice doesn't reach the receiver with much volume, and this makes a much better recorder connection. The adaptor as built uses plug-in connections so the unit can be put away when not in use.

An incidental feature of this unit is that the records may be played back over the telephone merely by setting the controls for playback and turning on the switch with the recorder still connected to the phone. The volume can be adjusted to suit with the front control on the recorder as in ordinary playback with headphones.

The telephone recorder in use helps the dispatcher by relieving him or his clerk of the job of recording all details of each fire message during the conversation. Orders for manpower and equipment may be verified by playing back the disks, and any instructions given or agreements made are put on record. The net result is that chances of error in recording detailed messages are reduced, with the dispatcher free to take brief notes, depending on later playback for details such as subsistence or other requisitions.

BATTERIES FOR HEADLIGHTS

CHARLES P. EGGER
Electronics Engineer, Forest Service Radio Laboratory

The dry battery, supplying the need for packaged electricity to headlights is one of the common and most necessary articles used by firefighters. Important technological developments stimulated by World War II and the "Space Age" have brought about a sudden demand for new batteries. This has led to improved types for existing applications, as well as new batteries to meet new service requirements. This report gives information on the relative efficiency of new design types of batteries for headlights.

Manufacturers have shown considerable interest in making batteries that meet the general requirements of the Forest Service. They have furnished us with engineering samples and invited our comments and recommendations. This cooperativeness from industry has been utilized by making laboratory evaluation tests and providing field tests to determine whether the batteries meet our needs.

Standards in industry for batteries of the same type are not too consistent. For example, batteries classified as "industrial" types by different manufacturers differ widely in life characteristics, total capacity, storage life, and price. One manufacturer makes five different kinds of flashlight size "D" cells, under classifications of regular, industrial, heavy-industrial, radio, activator, energizer, or other distinguishing nomenclature. These batteries are intended for a particular type of service, though the claims of the manufacturer are sometimes not clear.

The "D" size flashlight cell has long been generally used in headlight service. It is a cylindrical (nominal dimensions 1¼ inches in diameter, 2¼ inches in height), zinc-manganese dioxide mix dry cell commonly called LeClanche after its inventor. However, the voltage produced by these cells under high, continuous drain service drops at a high rate, resulting in poor performance of headlights and frequent changing of batteries. Leakage, swelling, and corrosion due to perforation of the zinc can is a problem. Large quantities of dry cells of all types are thrown away each year because of deterioration in storage.

This investigation has included the following:

1. Comparative information about service and shelf life on the different types of "D" cells.
2. A study and evaluation of the magnesium-cuprous chloride (water-activated) battery.
3. A study and evaluation of an alkaline mix battery in the "D" and "½D" size.

The test that best represents any particular service is that which most nearly duplicates the rate-of-energy output of the battery when in actual use. Most of the batteries were given continuous and intermittent duty tests, made when the batteries were fresh and after they had been stored for given lengths of time. Continuous discharge reveals the general discharge characteristics more quickly, but these characteristics are not conclusively related to results obtained in intermittent tests. The tests that we used approximately duplicate conditions of our particular use where the goal is to furnish the best possible light output from headlights for a minimum of 8 hours continuously (in night-shift firefighting for example). The intermittent duty test cycle of 8 hours discharge with 16 hours recuperation time was chosen to determine if more than one night's service could be obtained with the more expensive types of "D" cells.

Visual inspections for corrosion were made when the cells were removed from storage. Samples of alkaline and water-activated batteries designed especially for headlight service were purchased and distributed to the regions for field tests with sample headlights (fig. 1).

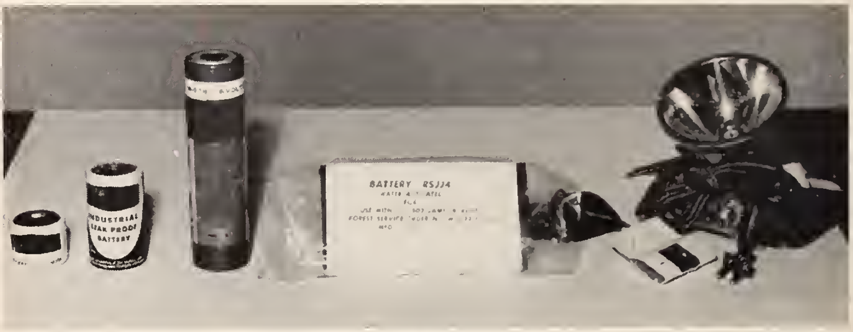


FIGURE 1.—Batteries: "½D," "D," alkaline plug-in, and water-activated; economy headlight.

From the test results in the laboratory and the manufacturers' published data, "D" cells are classified according to service life in hours as follows:

Class I —Regular general purpose LeClanche cell.
Price range—.05–.06 (GSA stock item).
10–12 hours continuous service to 1 volt per cell.
12–15 hours intermittent service to 1 volt per cell.

Class II —Industrial or premium type cell.
Price range—.08–.16.
13–20 hours continuous service.
14–25 hours intermittent service.

Class III—Industrial or premium type cell.
Prince range—.10–.15.
21–29 hours continuous service.
26–34 hours intermittent service.

Class IV—Alkaline cell.
Price range—above .30.
More than 30 hours continuous service.
More than 35 hours intermittent service.

Comparative discharge curves, continuous and intermittent of cells of all classes, are shown in figures 2 and 3. For Forest Service use voltage below 4 volts is not considered adequate.

Class II cells do not give significantly longer life, on a cost per hour basis, in continuous duty tests than the cells of Class I (fig. 2). They do have somewhat longer life when tested in intermittent service (8 hours on, 16 off) but it is not commensurate with their increased cost. The terminal voltage falls near or below the specified end-point before the end of the second discharge period (fig. 3). However, the cells show potential use (after recuperation) though at voltage near the end-point.

Class III cells are clearly superior to either Class I or II cells, both in longer hours of service and a higher average terminal voltage, and on a cost per hour basis should be considered for use. Corrosive tendencies are a potential disadvantage. Five cells out of forty-eight samples of one manufacturer's product were corroded when removed from storage. After discharge, corrosion at the positive terminal was rapid on most samples. The manu-

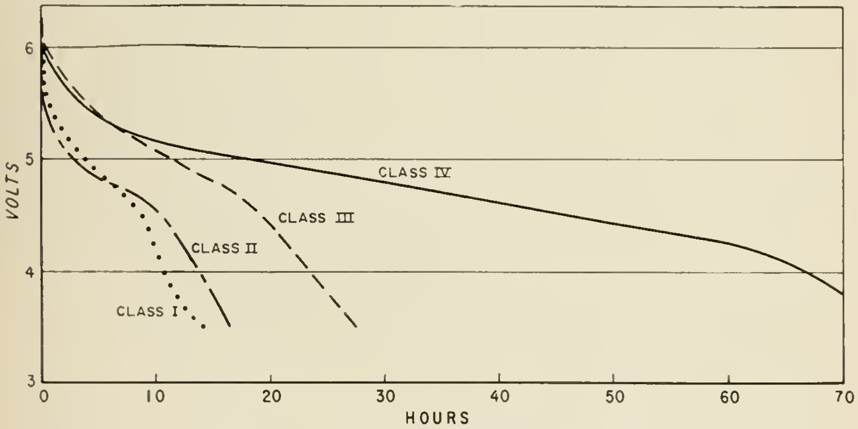


FIGURE 2.—Typical continuous discharge curves of classes of "D" cells.

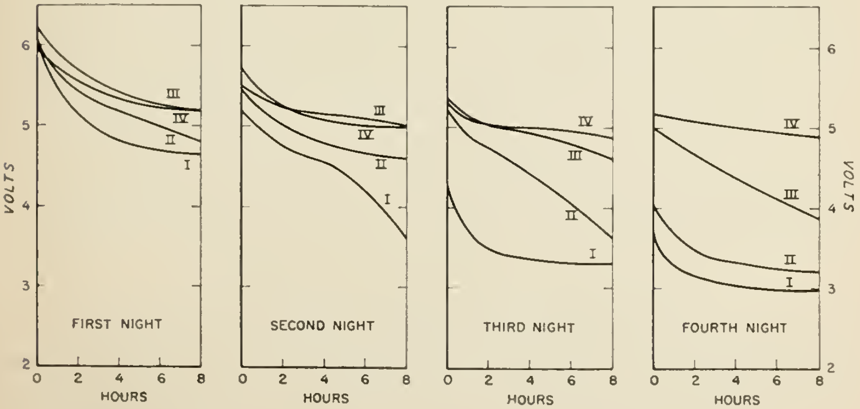


FIGURE 3.—Service life of "D" cells over successive 8-hour nights.

facturer says this is due to the use of a "hot" mix for longer life and greater capacity. This tendency toward rapid leaking and corrosion of this class cell has also been noted on another manufacturer's product which has recently been sent to the laboratory.

The Class IV alkaline cell is in a class by itself. Commercial manufacture is recent, although cells of this type were first described in literature in 1912 and were studied sporadically up to 1936. In the original form it was of a wet type, nonportable, large, and restricted to an upright position. Improved manufacturing techniques have enabled production on a commercially practical basis. It has been described as a combination of good features of the LeClanche and Mercury types of batteries. The discharge characteristic shows that its curve is flatter and many times longer than the LeClanche (Classes I, II, and III) (fig. 2). While it costs about five times as much as a regular "D" cell, it does provide proportionately longer service as related to cost, especially at heavier drains.

After 18 months of storage at room temperature, Class I cells showed a service life loss of about 20 percent. The average capacity (ampere-hours) and service life loss of all cells was 25 percent and 22 percent respectively. Class I cells are below this average (23 and 18 percent). It appears that as designs are altered in Class II and III cells to give longer service life and greater capacity, it cuts into the shelf life. It will take more data and experience to determine whether these advantages are greater than the loss in shelf life and increased initial cost.

Research and development on improving the shelf life of LeClanche cells is an active program throughout the industry. Within a relatively short time, the storage life will probably be quoted as 3–5 years with at least 50 percent of initial capacity.

Alkaline cells have not been available long enough to make any definite conclusions about shelf life. One test made on this battery after 8 months storage indicates loss of shelf life comparable with Class I "D" cells.

Improved "D" cell construction has almost entirely eliminated leaking and corrosion. After 18 months of storage at room temperature, none of the cells showed any corrosion or swelling, either before or after discharge. With the exception of the Class III cells, mentioned previously, zinc can perforation or corrosion at the positive terminal of all other types has been negligible.

The electrolyte mix used in the alkaline cells is more liquid than the zinc manganese-dioxide LeClanche mix. The manufacturer has had the problem of providing for cell "breathing" yet effectively preventing the electrolyte from leaking. We have had only two incidents of leaking and corrosion, both after complete discharge of the cells.

WATER-ACTIVATED BATTERIES

The water-activated cell systems are among the relatively new power sources which show definite advantages in headlight use. The outstanding features of this battery are indefinite storage without serious deterioration and a constant voltage throughout its useful life. The batteries are stored dry in an inactive condition in hermetically sealed containers and are activated merely by adding water.

The sustained higher terminal voltage of the water-activated battery is shown in figure 4. This would produce a more brilliant light over the period of its use. It takes about 2 hours to reach full voltage of 5.5 volts, but usable output occurs in 5 to 10 minutes. As long as moisture is present in the battery it will continue to dissipate itself until the chemical reaction is complete, whether under load or not. Adding more water will not extend its life. Leaving the battery submerged in water reduces its service life.

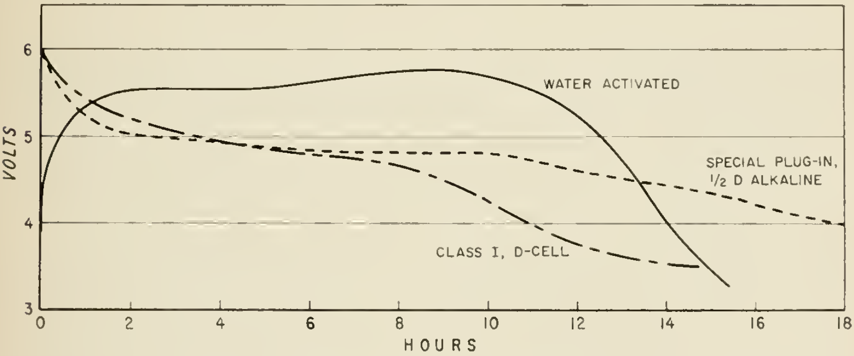


FIGURE 4.—Comparison of continuous service life of alkaline and water-activated headlight batteries.

Although this battery is supposed to have no deterioration in storage, laboratory tests disclosed some loss in service life of batteries that were stored on the shelf and sealed in plastic bags only. The average capacity loss of four batteries stored for 8 months at room temperature was 21 percent.

We believe that the plastic material used for a container does "breathe." Any moisture from the air would cause partial activation during storage. This could be a serious problem in humid climates. Therefore, water-activated batteries should be stored unopened in the original shipping cans until distributed for use. If only part of the contents of a can is used at one time, the can should be resealed to prevent any deterioration. Batteries stored for 8 months in sealed shipping cans showed no loss of service life.

During and after discharge, a green, corrosive-looking residue is produced. This residue is not harmful to skin, clothing, or metals. Several inquiries have been received about the odor of the batteries during storage and during use. It is not explosive or toxic. The opening of large quantities of these batteries in a confined space should be avoided as the accumulated odor can be obnoxious. The battery has the characteristic of evolving heat during discharge. This makes them applicable for operation at very low temperatures.

ALKALINE PLUG-IN BATTERY

Another type of battery made by a manufacturer for headlight service uses the alkaline-mix electrolyte (Class IV) cells of size "½D." A series-connected package of four of these cells with a socket (ASA IV) make up a self-contained 6-volt headlight battery with increased service life and total power output over standard "D" cells (figure 4). Generally, the data presented about the Class IV cells apply to this one except that its total capacity is less because of smaller size. Its service life is about 18 hours compared to 11 hours for a Class I "D" cell.

The alkaline and the water-activated batteries will furnish a longer and brighter power source in headlight service. The alkaline battery and the economy headlight make a good combination for general intermittent uses, while the water-activated battery makes an excellent power source for one period of continuous use. Both batteries can be used interchangeably with the economy headlight since no battery container is needed and a standard 6-volt socket and plug is used. Forest Service specifications have been issued for each type of battery and the headlight.[1] Cost of the batteries, while relatively high now, will be lower as purchase volume increases.

A test and evaluation program on all types of batteries that might be adapted for headlight use is continuing at Beltsville under the Technical Equipment Development Program. Engineering samples of a new type of LeClanche cell, using a "cathodic-envelope" type of construction, has been sent to us. This one shows promise of about three times the life of a "D" cell with a higher average discharge current.

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[1] Specification 150—Economy Headlight.
Specification 160—Alkaline-Type Dry Battery (6 volts).
Specification 161—Water-Activated Battery (6 volts).

PORTABLE TOWER

STUART B. MCCOY
*Ranger, Tomahawk Forest Protection Headquarters,
Wisconsin Conservation Department*

A portable tower that can be erected to a height of 102 feet in less than a day, and requires no nuts, bolts, or other loose parts in its erection, is now in use by the Forest Protection Division out of the Tomahawk Headquarters (fig. 1).

This tower is composed of 17 aluminum-alloy, upright, one-piece folding sections which are easily transported from place to place on one long-wheelbase truck. Each section is 4 feet wide,

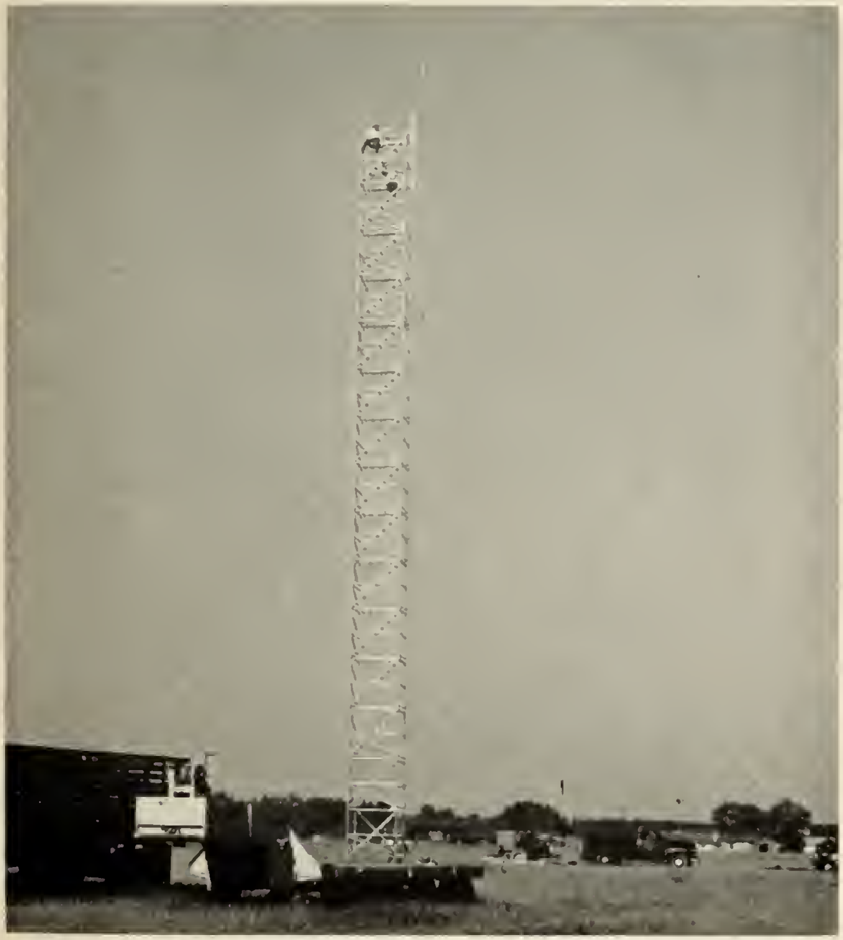

FIGURE 1.—The 102-foot portable lightweight observation tower in use by the Forest Protection Division.

6 feet deep, 6 feet high, and has a 7-rung stepladder in its interior. Special locking hooks join the folding parts together. Each separate 6-foot section is likewise securely fastened by a stainless steel pin to lock a specially designed hook in place.

The tower can be erected in any location and requires only a plank foundation. It is guyed with cables to prevent swaying in the wind. Interior stairways have a self-cleaning scraper-type tread on each step which removes snow, mud, or grease from the climber's shoes.

This tower will have three important uses. It is now being used in many different locations throughout the State in making a survey of radio signal strength. The present forest protection radio frequency is subject to considerable interference from foreign radios particularly in Central and South America. Spanish-speaking voices often break in and drown out communication even on bad fire days. New frequencies are to be assigned, and it is hoped that by the use of this portable tower the ideal frequency that will be free from interference can be determined.

There are over 130 permanent observation towers now in use. Growing trees, changes in district boundaries, and poor original locations make relocations necessary from time to time. Presently the highest hill in the neighborhood is selected as the site, but the actual view that will result is never known until the permanent tower is erected. Oftentimes nearby ridges or other hills cause blind spots. This can be avoided if the preliminary tower investigation includes a "look see" from a portable tower. The exact height required can be determined beforehand.

A third use will be observing large burns that may require watching for several days after the initial control action. From a tower set up in the center of a large burn, a watcher can detect immediately any new smoke which gives warning of a possible danger near a plowed line or of a windblown spark that has jumped from the burned to unburned area and threatens a new conflagration.

PLATE GLASS FOR OLD FIRE TOWERS

CARL BURGTORF
District Ranger, Cumberland National Forest

This experiment included the removal of the nine-pane, metal-sash window frames from a 7- by 7-foot cab steel fire tower, and the substitution of plate glass of the quality used in department store windows. Salvage glass from large display windows was used in our final installation.

Considerations in making the change.—(1) The excessive glare and heat from the vertical glass could be reduced. (2) Since it was obvious that more sky was exposed than necessary for adequate coverage of the land surface watched by the towerman, glass area could be reduced. (3) The old sectional frames were hard to adjust for ventilation. (4) Caulking around frame joints and glazing was difficult. (5) Rain streaks and dust accumulated on the vertical glass, and the small sectional windows required frequent cleaning. (6) The sash caused obstruction to vision and shadow effect not present on large windows tilted out at the top.

Installation of new frames and glass.—After removal of the old window frames only the angle-iron tower corners remained to support the cab roof and to provide support for the new framing material. The opening created extended from a point 43 inches above the floor to the cab ceiling, a vertical space of 42 inches.

The top line of vision for a tall man was marked by actually sighting across the cab interior and including enough sky so that only a narrow area above the horizon would be visible. The lower edge of the required line of vision was marked on the frame, and we found that we needed only 20 inches of vertical glass area. Towers in steep mountainous area may require more glass height.

Three and one-half inch galvanized angle iron, salvaged from an old tower frame, was used for the top and bottom horizontal frame for the new window. These two pieces are wedged, with lead wedges made in the required shape, so that the two flat surfaces are parallel to each other and perpendicular to the edges of the glass. This allows a tilting of the upper edge of the plate glass outward about 2 inches beyond the vertical to reduce sun glare and reflections (fig. 1).

The angle iron corners present a narrow edge of steel to the window area which must be widened to about 3½ inches to complete the frame. The welding of a flat piece of galvanized iron, 3½ inches by ¼ inch thick and the needed length is a simple way to complete the side of the frame.

The plate glass is mounted in a "U" shaped channel which becomes a permanent track and protection for the bottom edge of the glass. This metal edge rests on ball bearings (fig. 2) of the "show-case" type of double channel which is permanently screwed to the angle iron surface. The top of the glass slides in another double "U" channel which serves as a guide and part of the permanent framing.

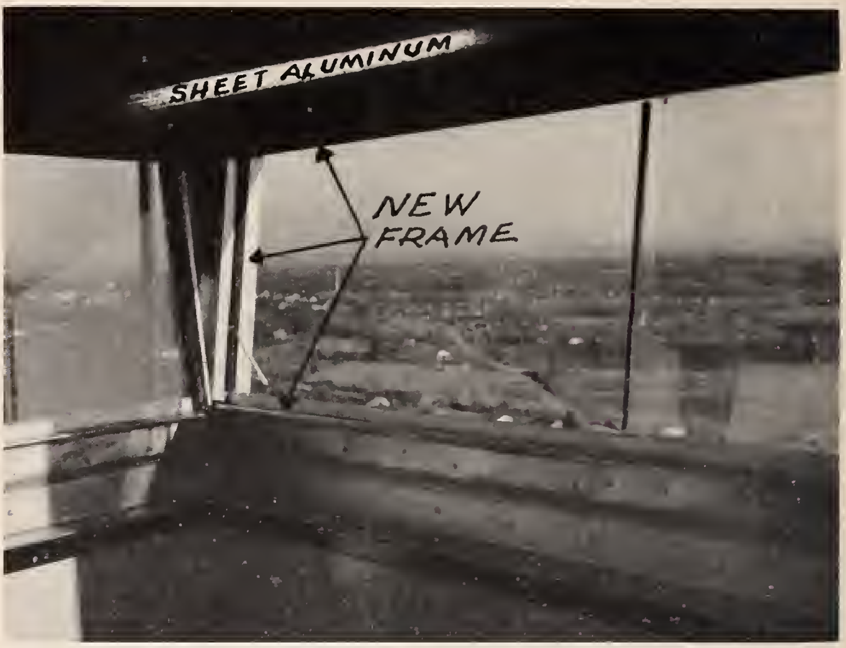

FIGURE 1.—Three and one-half inch galvanized angle iron, salvaged from an old tower frame, was used for the top and bottom horizontal frame for the new window.

Plastic caulking compound was used to seal all cracks between welds and metal joints. A rubber weatherstrip was cemented to the flat metal surface so that the end of the plate glass closed against its edge thereby making a weatherproof seal.

The two glass windows slide past each other to provide ventilation and for ease in cleaning the outside surfaces. The space between the two glass surfaces may be sealed against wind and rain by cementing a narrow rubber strip to one glass surface allowing space for movement.

The plate glass used is 8/32 inch thick with two ground surfaces and must not be confused with ordinary 7/32 inch plate which usually has too much distortion for tower use. We secured glass with a slight tint of green color.

The remaining space between the new frame and roof is sealed with aluminum "valley" metal, held in place with rustproof metal screws. Cracks are sealed with plastic caulking compound and all metal painted with aluminum paint.

Summary of experimental installation and results.—Removal of the old window frames, cutting and fitting of angle-iron frame material and filling in with aluminum sheet-metal was accomplished by the towerman and regular district personnel. The glaziers performed their work on a contract basis; this included the double-track channels, top and bottom, cutting the plate glass and grinding the edges for safe use, cementing a "U" track to the

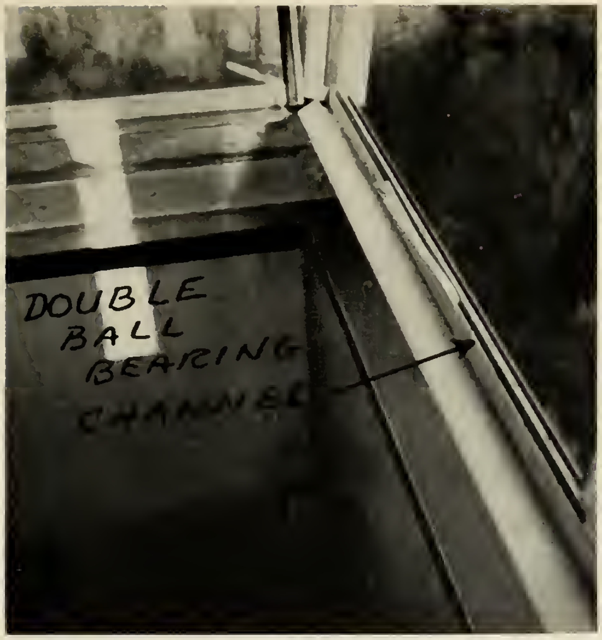

FIGURE 2.—The plate glass is mounted in a "U" shaped channel which becomes a permanent track and protection for the bottom edge of the glass.

lower edge of each glass to act as a protective running strip, and final fitting of the glass. The cost of glass installation, including the glass, channel materials, and the services amounted to $45 per side, or $180 for the 7- by 7-foot cab.

Satisfactory results from the new plate glass windows include greater visibility, especially during evenings and mornings when the sun is low; greater ease of cleaning with less streaking from dust and rain; much less heat from the sun's rays and a tower that is easy to ventilate and much more comfortable for the towerman.

USE OF FIRE IN FOREST MANAGEMENT[1]

Robert D. McCulley
Chief, Division of Forest Management Research, Lake States Forest Experiment Station[2]

Fire is used in timber management mainly to help establish new stands. Prescribed fire can improve the seedbed, clean up green and dead fuels from a planting site, or control undergrowth during the life of a stand so that competition with seedlings can be held to a minimum when reproduction cuts finally are made. Its use for these purposes has been limited to certain geographic locations and to timber types where conditions of weather, fuel, and topography offered special reason to expect success. This has been mainly in the South and West.

Natural fires influence forest composition

That fire has had a relationship to the kind of timber in the forest is long established. This seems obvious for jack pine, lodgepole pine, and other species that may require high temperatures to release their seed. It is equally true of those species that lose out in competition with their more tolerant neighbors if some disturbance such as fire does not upset the trend of succession. Douglas-fir is such a tree. So are white pine, loblolly pine, quaking aspen, and many others. The list is long, and it tends to grow longer as we glean more ecological information from the forest.

Fires favor certain tree species in several ways, thus perpetuating cover types that tend to lose out in competition with those higher on the successional scale. They kill back the competitors and, if intense enough, reduce their numbers. They remove litter accumulations and expose mineral soil, the favored seedbed for many forest trees. Also, in general, they provide the conditions of light, temperature, and moisture relations that, temporarily at least, favor the establishment and growth of the so-called fire types. Fire species tend to be light seeded and aggressive in filling in denuded areas. They are intolerant of shade.

Prescribed and uncontrolled fires may not produce same effects

A forester's first acquaintance with fire was generally in trying to control it. As a byproduct of its destructiveness he saw some of the things it accomplished in selected areas—the freshening of forage for domestic livestock in the South, the fortuitous thinning of dense young stands of ponderosa pine, the sanitation removal of brown-spot needle blight of longleaf pine, the release of seed held in serotinous cones of jack pine, the improved seedbed and generous establishment of numerous species in all sections of the country.

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[1] Condensed from a paper given at the Region 9 Fire Meeting, June 12, 1958.

[2] Maintained at St. Paul 1, Minn., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Minnesota.

However, the link between the action of wildfire and the prescription and use of fire for specific purposes is not necessarily very strong. The users must assure control within prescribed boundaries. And damage to residual trees must be held within tolerable limits. These limitations tend to reduce the intensity of prescribed fires and thus to curtail their effectiveness for some purposes. Fire intensity especially is a problem where selective action is desired where unwanted vegetation must be killed and valuable vegetation saved.

Properly prescribed fire does not seriously threaten soil productivity

Many foresters are apprehensive about the long-term effects of fire use on the soil. Generalizations on this point pervade the literature. Yet there are few things less subject to generalization. The possible variation in any fire situation is tremendous. It is not enough to assume that because organic litter is a valuable soil conditioner, and because fire destroys litter, that fire necessarily is destructive of soil values. There is much more to the story than that.

In some situations fire certainly lowers soil productivity. I can outline a case where there can be little argument. South of Plymouth, N. C., is a stretch of country that can only be described as desolate. To a forester it may resemble early photographs of the stumpland wastes left after removal of virgin white pine and the subsequent fires in the Lake States. As far as the eye can see stretches a swamp populated by cotton bullrushes and other aquatic vegetation. Stumps and snags poke up through it. This is the result of fire following logging on organic soil. The soil itself has been burned away, making natural establishment of trees impossible.

Another case is where fire removes the protective mantle of organic matter from the soil and destructive erosion results. The extreme example is the Southern California mountains where flood has followed fire on many an occasion. Less spectacular, but no less serious destruction of the soil has occurred in many other places.

If we rule out places where peat will burn and where erosion is a serious complicating factor, we come to an area where there still is much room for difference of opinion. However, the evidence from research on the effects of fire on the soil can narrow that area of possible disagreement.

First of all fire temperature seems to have very limited influence on the mineral soil itself. Soil samples from burned and unburned areas were analyzed following the severe fires of 1918 which destroyed Cloquet, Minn. They showed no loss of nitrogen from the surface layers of the mineral soil. Except where heavy fuels burn for long periods of time, as may occur in slash disposal, the temperature effect downward into the soil is limited to a very thin layer.

Soils from which the organic mantle has been burned away, time and again have shown higher levels of some nutrients other than nitrogen than similar unburned soils. Even though nitrogen is driven off from the litter as one of the products of combustion, the loss is of questionable importance at least in some cases. Prescribed fires seldom burn away all of the undecomposed organic material, and may remove a negligible amount. Many cases of a nutrient situation after burning have been shown by chemical analysis, by comparative growth of annual plants, and by comparative growth of pine seedlings on burned and unburned areas. There is no long-term history of soil nutrient relationships under controlled conditions. However, even though the story is incomplete it gives us some assurance that periodic use of fire poses no serious threat to soil productivity from the nutrient standpoint.

On the other hand the physical condition of the soil is impaired by repeated clean burns. Where this occurs it will accentuate runoff problems. A single, severe slash disposal fire in Douglas-fir, under current slash-burning practices, has only a minor influence on physical characteristics of the soil.

The main use of prescribed fire in this country has been for protection. However, in a few instances it has become a standard tool in timber management. Notable is its use for hardwood brush control in the South and Southeast.

Some of the variability in fire effects can be reduced by modifying the fuels. In the California foothills brush has been made more flammable through being mashed down with a bulldozer and allowed to cure before burning. Areas treated in this manner can be burned when the general fire hazard is relatively low. Area ignition, the simultaneous firing of numerous places in the burning unit, has achieved somewhat the same results through providing a quick buildup in temperature with resulting intense and clean burns. These methods of increasing the intensity and uniformity of fires have been used in range improvement work. They have possible application in replanting site preparation.

Effects of seedbed improvement with fire have been worked out for several of the soil conditions within the loblolly pine type. In general, the improvement is substantial but not as great as with mechanical scarification. However, fire has been less expensive to apply. Results are good where bird and rodent populations are low and where climatic extremes do not lead to heavy losses of germinated seedlings. Burning favors successful establishment of longleaf pine. Variable results from field trials have been reported for many other species including jack pine.

To sum up the present status of fire use, we can point to relatively few places where it is included in the routine of timber management. Hardwood control in the South is the major one. There are many examples of application on a small scale. There are even more test runs of an investigative character. Solution of problem situations through fuel modification or by other means can be expected to broaden general application where some of the limited trials now are being made.

"COOL" BURNS AND PINE MORTALITY

E. R. Ferguson, C. B. Gibbs, and R. C. Thatcher
Nacogdoches Research Center
Southern Forest Experiment Station[1]

Fire damage does not always have to be spectacular to kill trees. In east Texas, on a 10-acre experimental area where prescribed burns have been used periodically to reduce the hardwood brush

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[1] Maintained in cooperation with Stephen F. Austin State College, Nacogdoches, Tex.

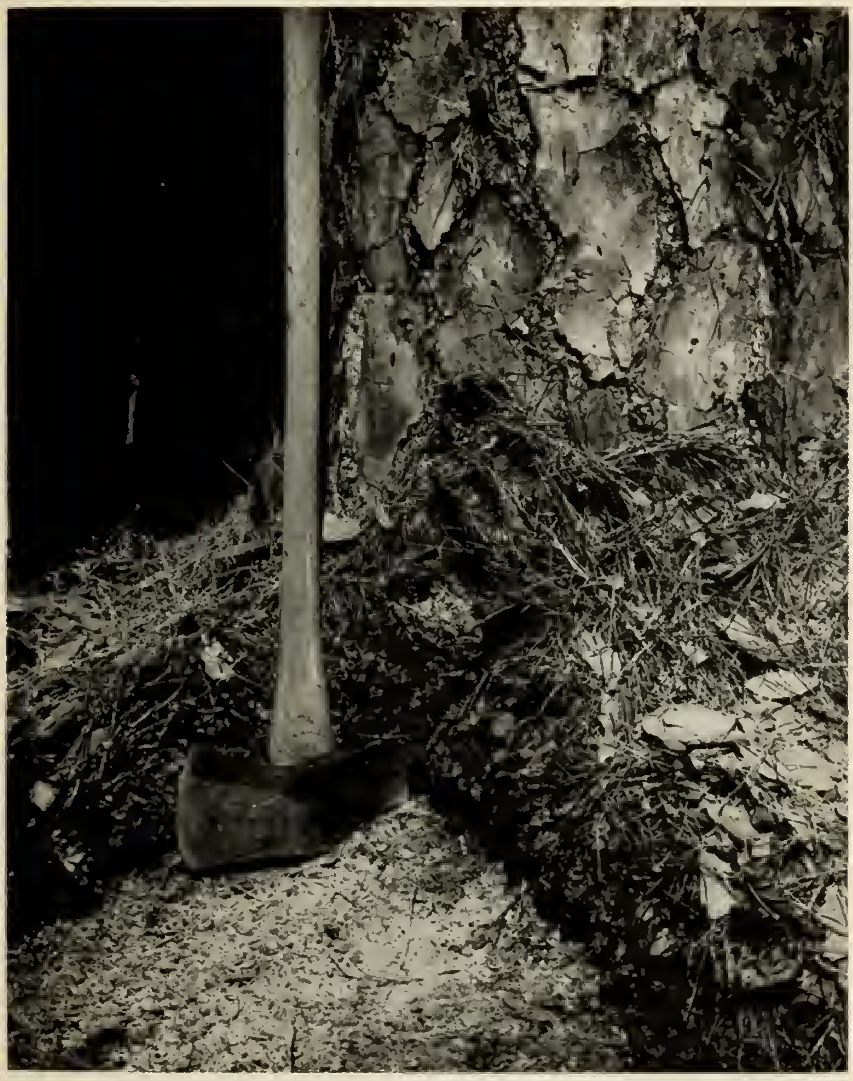

FIGURE 1.—Sloughed bark, dead needles, and other debris were piled up around the bases of large trees.

and to improve seedbed conditions, a low, creeping "cool" fire in October contributed to the death of 110 loblolly and shortleaf pine trees, approximately 10 percent of the merchantable stand.

Fuels were variable, ranging from very thin mantles of recently fallen leaves and needles to domelike accumulations of bark and needles at the bases of some of the pines (fig. 1).

Fuel moisture was estimated at 6 percent by basswood fuel moisture sticks. Wind velocity was variable, but averaged 5 miles per hour at a standard weather station. Through much of the area, the lines of fire were difficult to sustain and flames were low and slow moving. Continual refiring was necessary to maintain an unbroken line, and coverage was quite spotty.

When the burned areas were inspected shortly after the fire, no trees were classed as damaged under the recently described criteria of crown scorch and trunk scorch,[2] which emphasize height and extent of char.

Approximately 6 months after the burn, the area was revisited, and there was still no apparent evidence of weakened trees in the stand.

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[2] FERGUSON, EDWIN R. FIRE-SCORCHED TREES—WILL THEY LIVE OR DIE? La. State Univ., School of Forestry, Fourth Ann. Forestry Symposium Proc., pp. 102-111, illus. 1955.

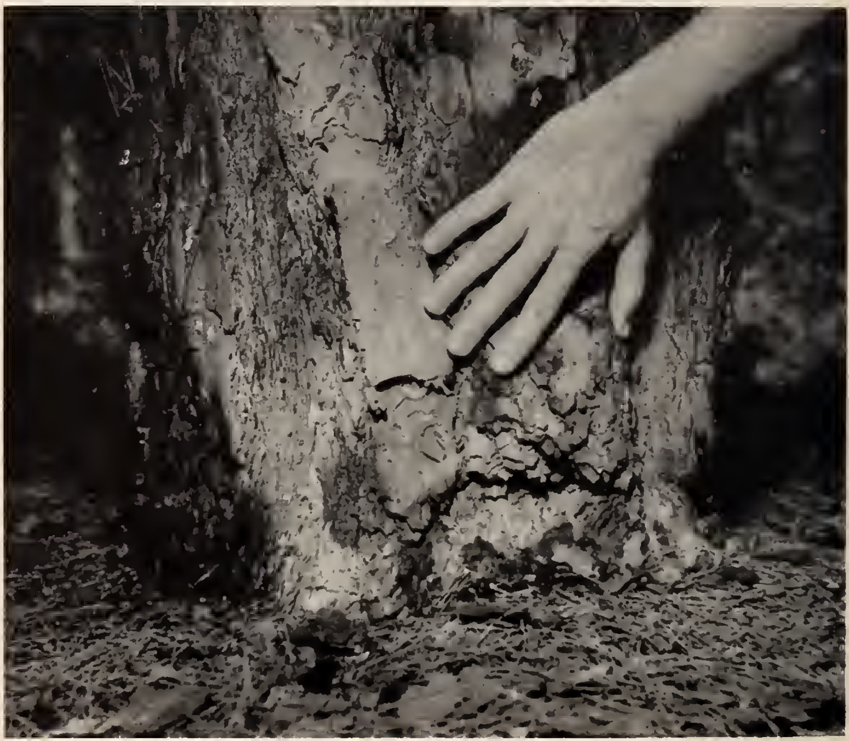


FIGURE 2.—Bark scorch was only stump high, but the intense heat burned away the heavy bark at the ground surface.

Then, 18 months after the fire, another routine check found many of the pines dead or dying. Turpentine beetles (*Dendroctonus terebrans* Oliv.) were active, and a number of trees with green crowns were under heavy attack by ambrosia beetles (*Platypus* sp.) alone.

Careful examination revealed that the primary cause of mortality was the fire. Although the scorch signs were rarely more than 8 to 16 inches high on the trunk, the fire had burned deep depressions in the bark—an indication of prolonged high temperature at the groundline (fig. 2).

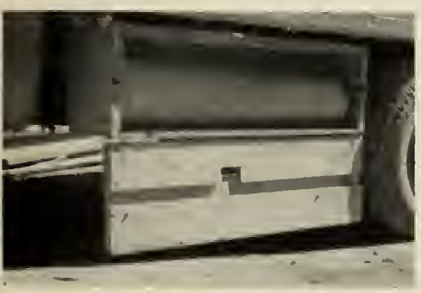
Attacks by the black turpentine beetle contributed to the mortality. However, the activity of the ambrosia beetle, which normally attacks only dead or dying pine trees, indicates that many of the damaged trees would have died had there been no turpentine beetles.

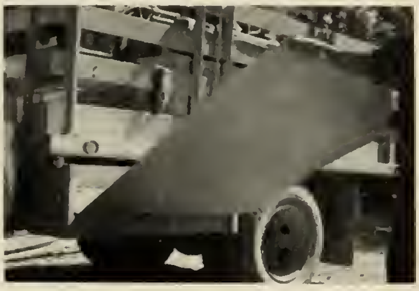
This experience suggests that assessments of fire damage, for salvage or other purposes, should not be limited to scorched crowns and trunks, but should also include low basal scorch, particularly following slow, low-burning ground fires in areas with heavy litter accumulations.

* * *

Box for Paper Used to Cover Slash Piles

Rolls of Kraft #30 paper used for covering piled logging slash are heavy and awkward to handle when being loaded, unloaded, or unrolled for cutting sheets to desired size. Transportation of the paper rolls requires either a separate vehicle or the roll must be securely tied down before crews can be safely transported in the same truck. It is difficult to unroll the paper and cut sheets without laying the roll down. Holes and tears in the paper are caused by objects on the ground or truck bed as the paper is unrolled. If the roll is new the weight of it requires two people to unroll it. Should the ends have been dented or bashed in while being handled or transported, unrolling without tearing is sometimes impossible.





We devised a carrying box that is bolted to the underside of a truck bed directly behind the cab and in front of the rear wheels. It holds the rolled paper on a pipe spindle. The box was designed for a 2-ton, 350-gallon tanker truck, but can be made any length the truck will accommodate.

This box will hold a roll 48 inches long and 12 inches in diameter. The paper is pulled through a slot and cut to length needed by pulling the paper up against the cutting bar which also serves as a covering over the slot. The cutting bar is 1- by 6-inch clear Douglas-fir held in place with spring loaded bolts. A metal cutting edge can be attached to the bar but is not necessary with kraft paper. The ends of the box are plated with ⅛-inch steel and serve as rock shields, reinforcement, and hangers for bolting to truck bed joists.—Robert Gilmore and Clinton Blaine, *Rogue River National Forest.*

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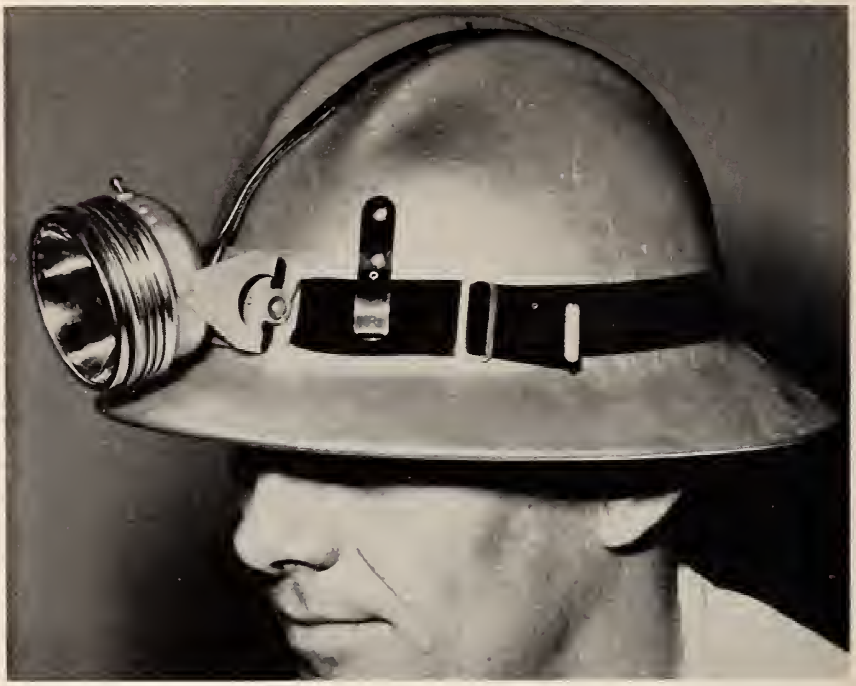
Metal Clips Replace Plastic Loops on Aluminum Hard Hats



Forest Service Specification 177a for protective hats was changed recently to provide for an improved method for holding headlamp bands. The metal clips are much more durable and make for a better looking hat than the plastic loops formerly used.—Arthur W. Jensen, *Forester, Division of Fire Control, U. S. Forest Service.*

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Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

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